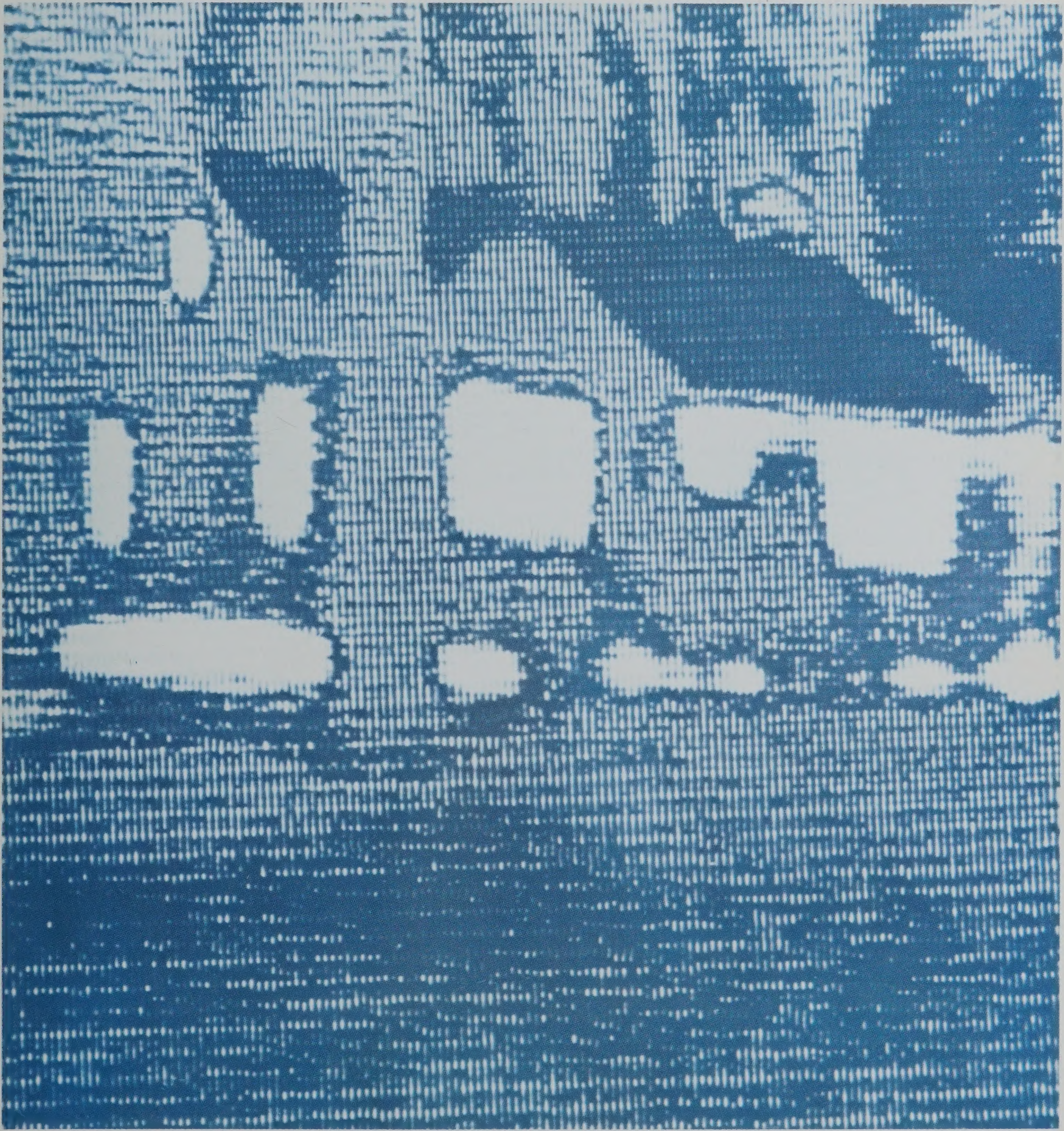
DIMENSIONS NBS

The magazine of the
National Bureau
of Standards
U.S. Department
of Commerce

September 1978



NEWS ON HOME INSULATION. See page 7.

COMMENT

ENERGY AND MEASUREMENT

The good news from Princeton last month brings us a small but significant step closer to the day when commercial power may come from fusion reactors. However, it should underscore, not obscure, the necessity for continuing to address the energy needs and priorities of today and the next several decades; for it is by exploiting these options that we can secure the technology base—as well as the social and economic health—needed to pursue long-range goals.

The implications for the National Bureau of Standards are profound. Increasingly, the Department of Energy (DOE) (the lead agency in energy technology development), other government agencies, and industry turn to NBS for performance criteria and measurement expertise. Such technical input is essential for evaluating the complex trade-offs associated with energy technology and its use. NBS responds by drawing on established competences and developing capabilities within many technical divisions.

For example, combustion of fossil fuels represents the number one source of energy. A large number of DOE programs focus on possible improvements in combustion technology and devices. Two essential components of this effort by NBS are (a) improved measurement technology under the real world "harsh" environment of utility and industrial combustors—be they innovative coalfired boilers, fluidized beds, or industrial furnaces—and (b) chemical kinetic data for combustion modeling. (A report on the Bureau's unique new laboratory capabilities for evaluation of combution measurement and diagnostic equipment will appear in DIMENSIONS early next year.)

Another area, the thermal performance of building materials and envelope systems (walls, floors, ceiling, etc.), is central in achieving improved energy efficiency in new and existing buildings. NBS and DOE have established a comprehensive five-year National program plan which identifies the research needed to meet this objective. For this effort, NBS is developing capabilities for measuring thermal conductivity of thick insulation (up to 38 cm) and thermal performance of complete wall assemblies (3 m x 4.5 m) under dynamic fluctuations of temperature, moisture, and pressure. See the related article by Mat Heyman in this issue of DIMENSIONS. Heyman also describes the Department of Commerce National Voluntary Laboratory Accreditation Program, a critical link between laboratory research and the quality of insulating materials found in the marketplace.

Another important concern is consumption of electric energy, which is projected to increase nearly three-fold by the end of the century. This growth will be accompanied by the use of very high voltage transmission lines (over 1000 kV), compressed gas underground transmission lines, and possibly superconducting transmission and storage. To help make this possible, NBS is developing advanced diagnostic techniques and instrumentation to identify aging mechanisms in compressed gas insulating systems; procedures for measurement of the electric field in the vicinity of high voltage transmission lines; cryogenic data and measurements for superconducting elements; and calibration techniques for electronic watt-hour meters that will enable use of innovative "load management" electricity rates. This work is being carried out cooperatively with DOE, the Electric Power Research Institute, the Gas Research Institute, and industry.

Finally, the Nation faces the agonizing problem of redeeming American manufacturing from its current energy-intensive base. Then the U.S. can again become the world pace-setter in industrial productivity. The effects on efficiency of developments in the fields of lasers, superconductivity, surface science, catalysis, and micro-electronic circuitry—to name just a few—will be substantial. NBS scientists and engineers are working at the frontiers of these technologies.

Energy, like measurement, is a means to an end, and, generally, both are essential in achieving broader social goals. Foreseeable advances in the areas mentioned and in other energy supply, conversion, and use technologies will require intensified NBS measurement efforts.

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National Bureau of Standards
U.S. Department of Commerce
Volume 62/Number 9

September 1978

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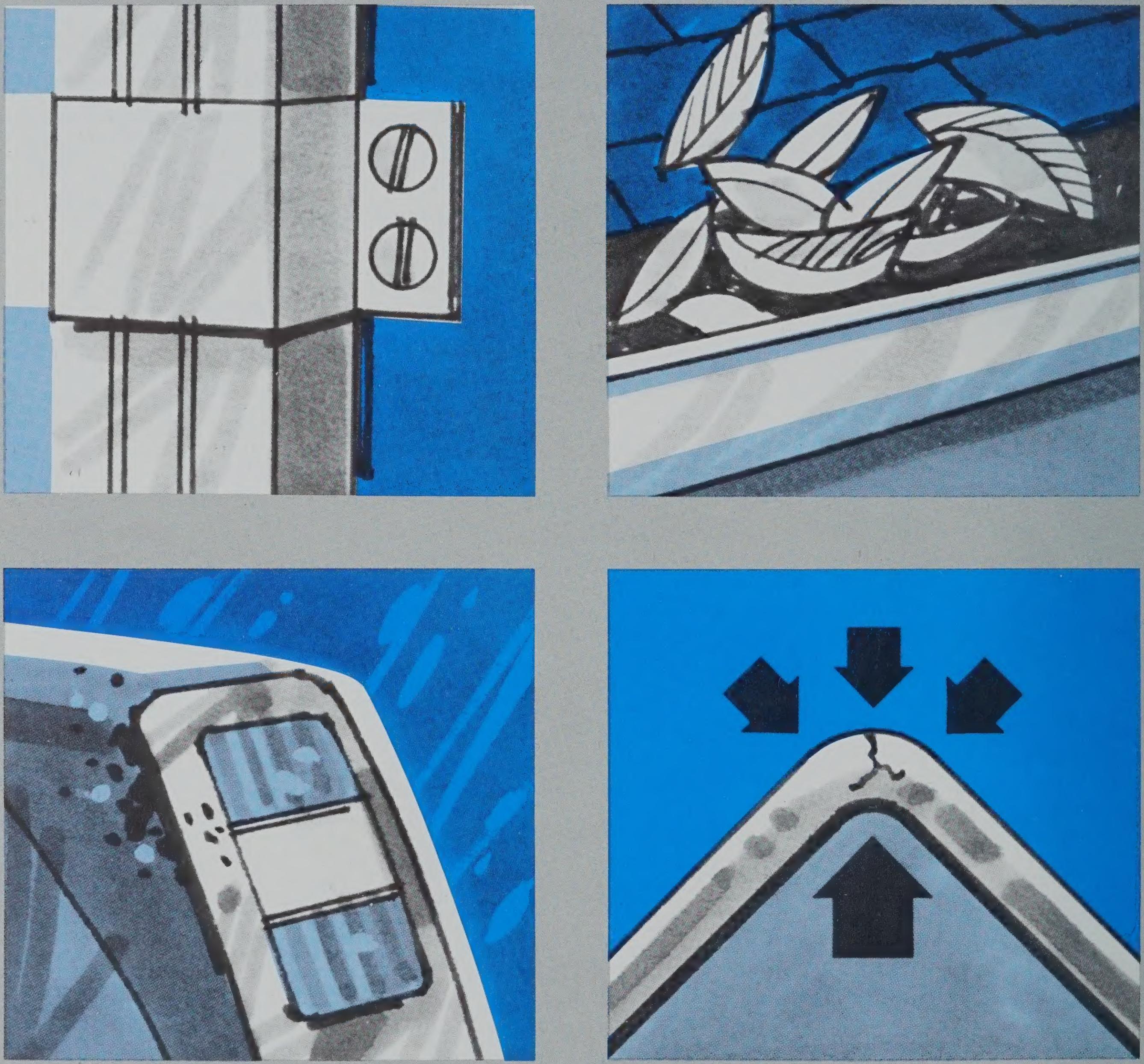

Facts for the Consumer

"Keep up your bright swords
for the dew will rust them"
—Shakespeare

TODAY, as it was in Shakespeare's time, rust or corrosion is the deadly enemy of metals. While the rusty condition of a sword may indicate inactivity, rust and other forms of corrosion usually signify that an "active" and destructive process is taking place. Corrosion is the destruction or "eating away" of metal due to its exposure to various environments, particularly moisture.

In addition to its unsightly appearance, corrosion can cause holes, cracks, or thinning in metal objects making them unsafe or useless. This pamphlet describes some of the ways that corrosion can be prevented, slowed, or stopped. The four kinds of corrosion are explained and guidelines for preventing or removing corrosion are provided.

by
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NBS CONSUMER INFORMATION SERIES 9
Editor: Suellen Halpin
Center for Consumer Product Technology
National Engineering Laboratory
National Bureau of Standards

This article is a reprint of Consumer Information Series 9. Single copies of the brochure are available from the Superintendent of Documents, U.S. GPO, Wash., D.C. 20402; price, 80 cents. Use Stock Number 003-003-01947-0.

TYPES OF CORROSION

IN order to combat corrosion, it's important to know the kinds of corrosion and the conditions that promote them. There are four major types of corrosion:

GALVANIC

Galvanic corrosion occurs when two different metals, for example, aluminum and steel are in contact with each other and are exposed to wet corrosive environments such as salt water, bleach, or detergent.

CREVICE

Crevice corrosion takes place when a portion of a metal object is covered by dirt, a gasket, bolt and rivet heads, or the like, and is exposed to corrosive environments.

PITTING

Pitting corrosion occurs when a very small bare metal area is exposed to a corrosive environment, for example, at a chip in the paint of your automobile. This type of intense corrosive attack results in holes or "pits" and can also occur on unpainted surfaces.

STRESS

Stress corrosion occurs when a metal that has been pulled or bent in the manufacturing process to produce a desired shape is exposed to corrosive environments. A crack in the metal piece often results.

HOW TO MINIMIZE CORROSION

THE more you know about corrosion, what causes it, and how it attacks metals, the better able you will be to combat it. Some metals are more susceptible to corrosion than others. In the diagram below, metals are rated from 1 to 12. The higher the number, the more susceptible the metal is to corrosion. To minimize GALVANIC corrosion, only metals rated closely in the scale should be used in contact with each other. When two metals are used together, the metal rated higher on the scale is more likely to corrode.

For example, if you combine copper pipe (rated 5) with ordinary steel pipe (rated 9) in a plumbing system, the steel pipe will frequently corrode. If an unfavorable metal combination cannot be avoided, coat the lower numbered metal with a good paint.

Some common galvanic corrosion-promoting combinations include:

- copper wire or iron objects left in the bilge and bottom of an aluminum boat;
- steel bolts and washers used to fasten brass sheets exposed to a marine atmosphere; and
- steel nails used to install aluminum gutters, or copper gutters installed with aluminum or galvanized downspouts.

CREVICE corrosion can occur if wet leaves are left in gutters or drains. To avoid or minimize crevice corrosion, keep metal surfaces clean. When gaskets are used with metal, choose plastic gaskets that will not absorb moisture. Remove wet packing material from metal objects in packing cases as soon as possible. If crevice corrosion occurs, caulk or solder the crevices as soon as possible.

To stop PITTING corrosion before it becomes a problem, cover holes in the coating with a new paint or lacquer where the rust spots or pitting first appears. This is especially important for automobiles. Be sure to remove all corrosion before applying a new coat of

1	2	3	4	5	6	7	8	9	10	11	12
Gold	Graphite	Silver	Stainless steels	Bronze, copper, brass	Tin	Lead	Lead-tin solders	Cast iron, ordinary steel	Aluminum	Zinc	Magnesium

turn page

paint or lacquer. If possible, avoid exposure of the metal to salt or salt water. Wash automobiles or other metals often when exposed to salt or sea-air.

It is difficult to protect metals against STRESS corrosion because most of the metals you purchase have stresses built in by the manufacturing process.

Certain metal-environment combinations are particularly vulnerable to stress corrosion. To prevent stress corrosion avoid the following combinations:

- aluminum alloys with salt water;
- copper, brass, and bronze with ammonia vapor and solutions;
- ordinary steel and ammonium nitrate fertilizer solutions; and
- stainless steel with salt water.

HOW TO PREVENT CORROSION

THE following are some simple steps you can take to prevent or inhibit corrosion:

PAINT

Paint has long been the major means of preventing rust by providing a barrier between the metal and the corrosive environment. There is a wide variety of paints on the market, many of which contain corrosion inhibitors. Epoxies, epoxy-coal tar, vinyl-alkyds, asphaltics and coal tars, silicone-alkyds, polyurethanes and phenolics, chlorinated rubbers, and zinc-rich paints provide good corrosion resistance.

The most important part of any paint job is surface preparation and the application of a good primer or prime coat. Thoroughly clean and dry the metal surface before applying primer or paint. Follow the manufacturer's recommendation for each type of paint, paying particular attention to proper surface preparation.

LACQUERS AND VARNISHES

Lacquers and varnishes are transparent coatings that protect the metal without hiding its original finish. Lacquers and varnishes can be used to protect many household items including bare metal table tops, rough-textured aluminum card tables, copper art objects, window screens, and metal doors. For best results use products containing acrylics, methacrylates, or butyrates. Before applying any lacquer or varnish, be sure to clean and dry the metal surface thoroughly.

INHIBITORS

Inhibitors are chemicals that are added to an environment to make it less corrosive or applied to a metal to protect it from the environment. Water displacing sprays or tarnish preventive sprays are available in most hardware, jewelry, and department stores for use on jewelry, silver, and metal art objects. However, the most familiar use of inhibitors is in the cooling system of your car. For more information about car corrosion, write: "Automotive Rust—Its Causes and Prevention," Consumer Information Center, Pueblo, Colorado 81009.

Most antifreeze and coolant preparations contain inhibitors to protect your engine cooling system from corrosion. Because the effectiveness of inhibitors is progressively reduced over time, it is necessary to add or reapply the inhibitor periodically.

Vapor phase inhibitors, available at hardware and department stores, can be placed in drawers and enclosed spaces to protect tools and silverware from corrosion.

GREASES

Greases, like petroleum jelly, are very useful for protecting tools or other metal items that are to be stored or shipped long distances. By coating the terminals of your car battery with grease, you can prevent unnecessary drains on your battery caused by the corrosion produced by battery acid.

OILS AND WAXES

Oils and waxes, such as the penetrating motor oils and liquid waxes, are effective when applied periodically to lawn mowers, tools, skis, ice skates, guns, fishing tackle, and water sprinklers. Thoroughly clean and dry the surface to be protected. Wipe oil or wax on surface with a cloth, making sure to cover the metal completely.

HOW TO REMOVE CORROSION

UNSIGHTLY rust, tarnish, and other corrosion can be removed from metals with a thorough cleaning. There are many metal cleaners available on the market that will do a good job if used properly. Or, you may prefer to try one of the home preparations described in this booklet. In either case, for best results, try the following procedure.

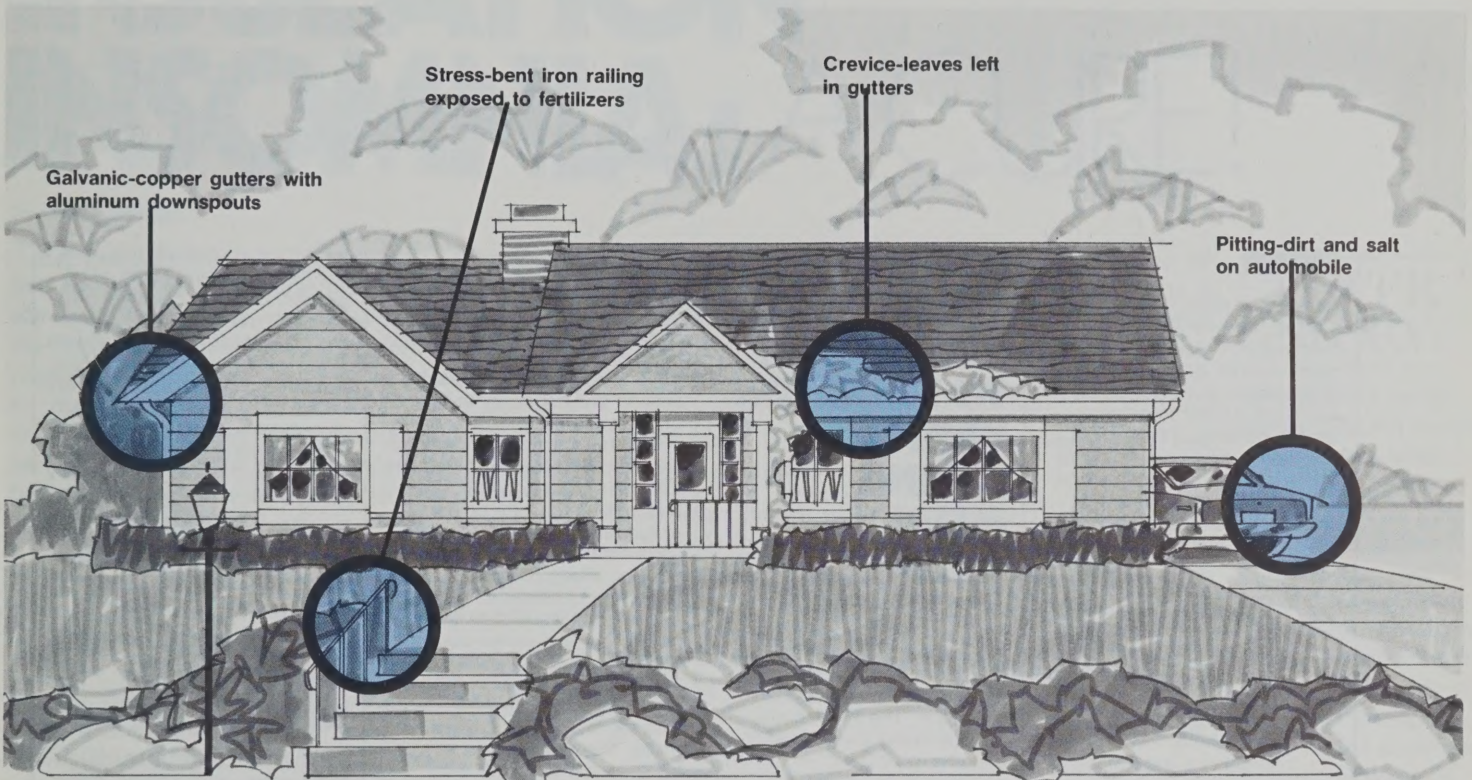
- Test the cleaner on a hidden area to make sure it will work and not do any damage.
- Follow directions carefully—this includes using the right amount of cleaner at the right temperature for the right amount of time.
- Do not mix cleaners.
- Remove the cleaner thoroughly, especially from cracks, corners, and holes.
- When working with any toxic or poisonous substance, wear plastic or rubber gloves as a precautionary measure.

Corrosion on all metals used in the home can be cleaned by using commercially available cleaners, but some home preparations are less expensive and are just as effective. All of the preparations given below are for removing CORROSION only. They are not intended for other stains or deposits such as burnt-on foods, grease, or dirt. In a few cases, the cleaning methods described here are useful for stubborn stains on which commercial cleaners are not effective or are less easy to use. Acid solutions should always be used with **caution.**

STEEL, CAST IRON AND WROUGHT IRON

For heavily rusted objects:

1. Dissolve 4 teaspoons of citric acid (or sour salt) in 1 quart of water.
2. CAREFULLY add small amounts of household ammonia to this solution, mixing thoroughly, and VERY CAREFULLY sniffing the mixture after each addition. After the first few additions of the ammonia you will not smell an ammonia-like odor from the mixture. Keep adding small amounts of ammonia and mixing until the mixture just starts to smell of ammonia again.



CORROSION AROUND THE HOME.

3. Now bring the volume of the mixture up to a total of 2 quarts by adding more water.

4. Place this solution in a large glass or enameled container.

5. Place the container on a surface burner of your kitchen range and bring the temperature of the liquid up to about 150 to 160 degrees Fahrenheit and maintain that temperature. Soak the rusty object in the hot solution.

6. From time to time, remove the object, rinse with clear water, and wipe it with a cloth to see how much rust has been removed. This procedure may take several hours. When you have removed all the rust on a heavily rusted object, you may find holes caused by the corrosion that were not conspicuous before cleaning. NOTE: This cleaning procedure is for iron and steel *only*. Ammonia will cause stress corrosion of brass.

For small rust spots:

1. Prepare a powder by combining 2 ounces of cream of tartar and 1 ounce of oxalic acid **(caution—poisonous).**
2. Moisten the rust spot, apply the powder, and leave it on for 10 minutes.
3. Rinse the object thoroughly with water and dry quickly to prevent new rust from forming.

ALUMINUM

The tarnish most often found on aluminum occurs in pots used to cook eggs or to heat certain types of tap water. This tarnish, usually a black or dark brown color, can be removed easily by cooking sour foods such as tart apples, sauerkraut, or tomatoes in the pot.

The white powdery corrosion sometimes found on aluminum can be removed by rubbing the object with a stiff brush, not stiff enough to scratch, while washing it with water and a mild detergent.

STAINLESS STEEL

The only kind of corrosion you will need to remove from stainless steel is the discoloration or "heat tint" that occurs after the stainless steel has been heated extensively in use. A stainless steel wool or scouring pad combined with a scouring powder is usually sufficient to remove "heat tint." If the discoloration remains some of the stainless steel cleaning preparations on the market can be used to remove it. You can also immerse or swab the object with a 5 percent oxalic acid solution **(caution—poisonous).**

COPPER BRASS AND BRONZE

Before attempting to clean any copper, brass, or bronze objects, remove any lacquer with a lacquer thinner and wash with warm water and detergent. After thoroughly rinsing and drying the metal, try one of these methods for removing tarnish:

A. Mix equal parts of salt, flour, and vinegar and apply the mixture to the metal with a dry cloth.

OR

B. Moisten the tarnished area with water and cover with salt and rub vigorously with a lemon half or slice.

OR

C. For tough stains, mix a few ounces of oxalic acid **(caution—poisonous)** with 1 quart of water. Wet a cleaning cloth in the solution, and dip the cloth into powdered pumice, and rub it briskly over the metal. Wipe with a clean dry cloth.

After removing the tarnish, wash the metal with warm water and detergent, rinse and dry thoroughly. To preserve the gleaming finish, apply a good lacquer to the surface. DO NOT lacquer copper-clad cooking pots and pans.

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SILVER

As with the other metals discussed, the many cleaning preparations available at your supermarket, department store, or hardware store will do an excellent job of removing tarnish on silver. However, if you have a silver item that has an intricately inscribed design that is difficult or time-consuming to clean, the following procedure may be worth a try:

1. Wrap the entire object in aluminum foil, making a few cuts in the foil to allow liquid to leak into the space between the silver and the foil.
2. Place the foil-wrapped object in a large glass, enameled, or stainless steel pot that can be placed on the stove.
3. Fill the container with a solution of water and bicarbonate of soda (4 to 5 tablespoons per quart of water) and simmer gently for 30 minutes. Use enough water to cover the object. The tarnish in the cracks should be removed by this procedure. If not, repeat.
4. Remove the aluminum foil, rinse, and dry the silver thoroughly.

WHAT CORROSION PROTECTION TO LOOK FOR WHEN BUYING METAL OBJECTS

MANUFACTURERS use a number of methods to protect their products from corrosion. The most common method is the application of metallic, polymeric, or ceramic coatings to the metal.

METALLIC COATING

The metallic coating most widely used is a zinc coating applied to steel. The resulting coated steel is called galvanized steel. Galvanized steel is used in the production of trash cans, gutters, water pipes, chain-link fencing, and siding. The quality of a galvanized steel is determined by the thickness of the zinc coating. The thickness is usually defined as the number of ounces per square foot of steel and ranges from ¼ ounce to 3 ounces per square foot. The more ounces of coating per square foot, the longer the galvanized product will usually last.

ELECTRO-PLATING

Electroplating is another widely used method of metallic coating. Electroplated items around the house include chrome-plated auto bumpers and trim, silver-plated flatware, household appliances, and tin cans (tin-coated steel). The coated objects take on the appearance of the material used for the coating such as copper, silver, or chrome. An important property of electroplated coatings is their thickness. The thicker the coating, the fewer pores, and the less likely pitting corrosion will occur. Some articles are plated with more than one kind of metal, for example an auto bumper that is plated with copper, nickel, and chrome. It then becomes difficult to compare on the basis of thickness alone.

Small pin holes, that can result in rust spots, may develop in electroplated surfaces. This can be controlled by cleaning off the rust, being careful not to damage the remaining electroplated surface, and sealing with a lacquer or wax.

CERAMIC COATING

Ceramic coated items you may encounter include enameled cooking utensils, glass-lined hot water tanks, and porcelain enamel-lined appliances. These coatings are usually applied to steel surfaces. Porcelain enamel on steel can be recognized by the following characteristics: will attract a magnet, cannot be scratched by a coin, and has an "orange peel-like" surface. Ceramic coatings offer excellent corrosion resistance and are usually pore-free. Some glass-lined hot water tanks are equipped with magnesium rods known as anodes for additional protection against corrosion should a defect in the coating exist. Though it will cost slightly more, a hot water tank with an anode is a worthwhile investment. Most glass-lined hot water heaters now come with anodes.

QUALITY OF WORKMAN-SHIP

Smooth rims, coatings, linings, and finishes without pits, chips or gaps are marks of good workmanship. They not only improve the appearance of the product, they also increase its durability. For example, rough edges or finishes could expose bare metal to a corrosive environment, or a defect in a porcelain coating could allow the underlying metal to rust and the coating to chip further.

With the information in this booklet you should be able to avoid much of the damage corrosion can cause. REMEMBER, nearly all environments are corrosive, but with proper care, corrosion can be prevented, slowed, or stopped. □

INSULATION INSOMNIA: A CURE!

by Mat Heyman

Are you suffering from a new disease common to homeowners called insulation insomnia? Here are some of the symptoms: You spend a lot of time worrying about whether to add more insulation to your house. You had your local contractor outline an insulation upgrading job, but you're skeptical that it will shave as much off your fuel bills as he said it would. You're in a quandary over which is better—6 inches of glass fiber batts or 5 inches of cellulosic loose fill.

And here's a real middle of the night eye-opener: A report on the evening news gave you the idea that the insulation you just had installed might go up in flames as fast as a bundle of kindling wood.

If you have just now sworn to put the very thought of insulation out of your mind and thus avoid this spreading disease, wait a moment. You could be making yourself the victim of a worse condition when the cold weather rolls around—the skyrocketing-heating-bill-blues.

Is there any relief? Yes. The National Bureau of Standards and other laboratories are working on a total cure for insulation insomnia, and the prospects are good. For now, they have answers to the following nagging questions.

Question: I want to cut home energy use, but where do I start?

Answer: Before you take a major step like insulation, do those things which cost little or nothing but will save you energy by keeping the heat in your house from escaping or by using less heat to begin with. If you think you might have a "leaky" house, your first steps might be to caulk and weatherstrip around windows and doors. Keep dampers closed

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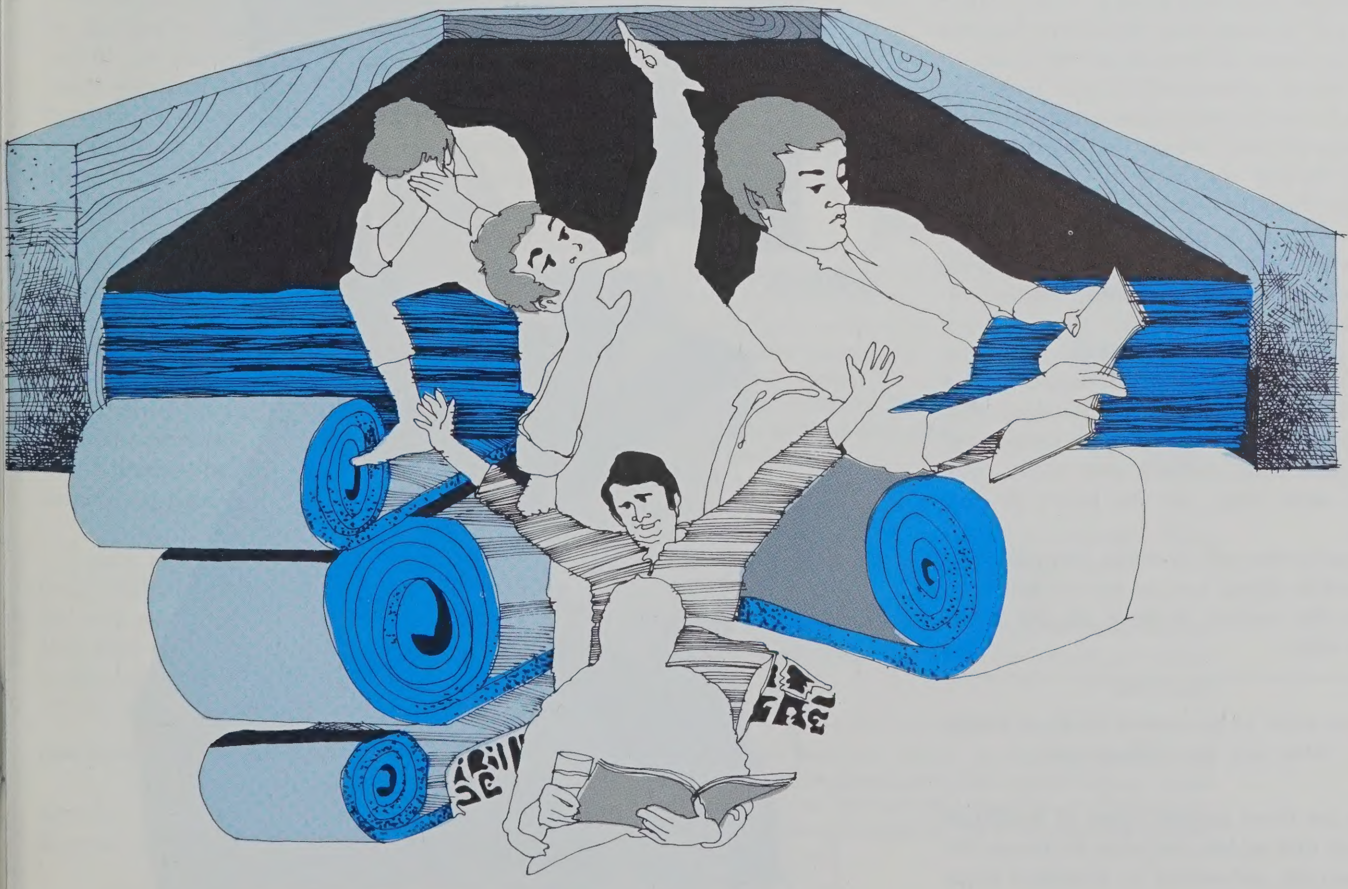
Heyman is a writer and public information specialist in the NBS Public Information Division.

COVER STORY:

This month's cover shows how the outside of a well insulated house looks when viewed with an infra red camera system. Such systems "see" a range of temperature differences and record them from dark (coldest) to light (warmest). Note that the light areas on the cover correspond to window areas. No heat is leaking from walls, ceilings, or around windows.



when your fireplace is not in use. In winter, open draperies on windows receiving full sunlight during the day to take advantage of solar heat, but close them again at night.

Also, if you are not turning down your thermostat during long periods when you are asleep or away from the house, you are missing an opportunity to save energy. Some people still wrongly believe that lowering and raising the thermostat uses more fuel than keeping the home at a constant temperature.

This is simply not true. Based on tests performed at the National Bureau of Standards, at other federal laboratories, and by manufacturers, NBS researchers say there is plenty of proof to show that such adjustments will save energy. [Despite some confusion about the matter, if you have an electric heat pump, you can still save by turning down your thermostat as much as 5 °F (about 3 °C) for several hours at a time during the heating season. You can temporarily turn your heat pump up any amount during the cooling season and still save.]

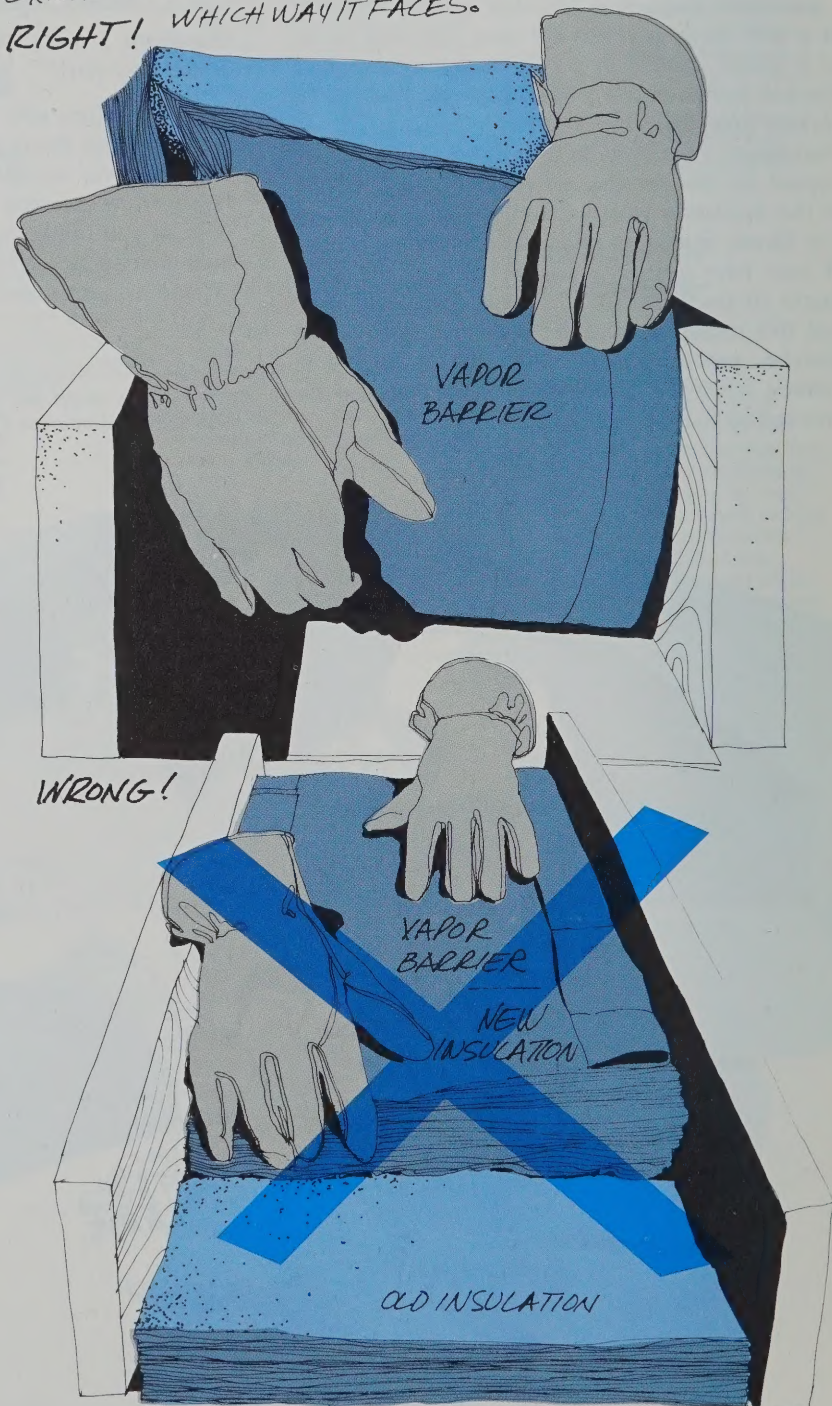
If you can't remember to make the thermostat changes, you might look into buying a clock thermostat which will automatically adjust your heating or cooling up or down at certain pre-set hours.

Then do an energy assessment of your home (or have one done for you) to determine what measures will yield savings of both energy and money. NBS has published *Making the Most of Your Energy Dollars In Home Heating and Cooling*, a pamphlet with simple worksheets to help you figure out your best energy conservation investment. (It is available by sending 70 cents to the Consumer Information Center, Pueblo, Colorado 81009.)

Some states and local communities are setting up special energy outreach programs designed to give you specific information about weatherizing your home. Don't overlook this assistance in doing your energy assessment. Also, contact your utility company and ask what steps can be taken in your particular area.

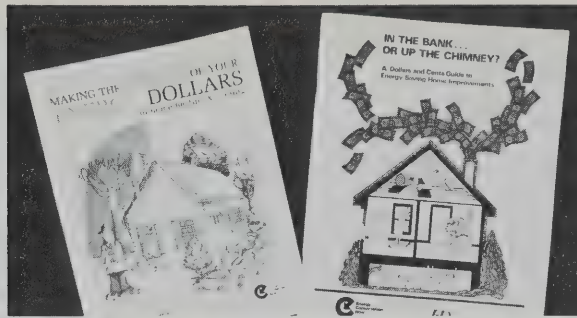
Insulation contractors will give you free advice on what you should be doing, but get several appraisals if you exercise this option. If there are big differences, find out why.

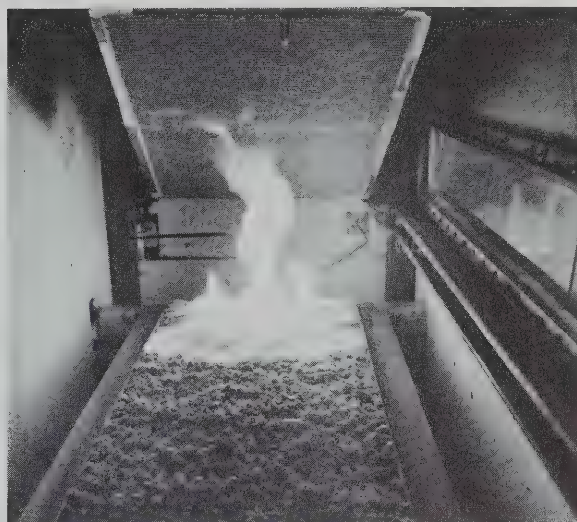
WHEN ADDING INSULATION BETWEEN FLOOR JOISTS IN THE ATTIC, CHECK TO MAKE SURE THE EXISTING INSULATION HAS A VAPOR BARRIER, AND THAT IT IS PROPERLY PLACED. THE VAPOR BARRIER SHOULD FACE DOWN WITH THE INSULATING MATERIAL ABOVE IT. — NEVER PLACE THE VAPOR BARRIER UPWARD! AND DON'T PUT A VAPOR BARRIER ON TOP OF EXISTING INSULATION NO MATTER WHICH WAY IT FACES.



Question: There seem to be several kinds of insulation available. What are the differences?

Answer: There are three general types of insulation material you will find widely available for home use. *Cellulose* is basically pulverized or shredded paper





Above. These booklets are aids to the homeowner who wants to know what to do to save energy and money. Energy Dollars is discussed on page 8. In the Bank, published by the Department of Housing and Urban Development, is for sale by the Superintendent of Documents, U.S. G.P.O., Wash., D.C. 20402; price $1.70. Use Stock No. 023-000-00297-3.

Left. The Attic Flooring Radiant Panel Test developed at NBS provides one measure of the relative flammability of various insulation materials.

which must be chemically treated to become fire retardant and vermin resistant while not becoming corrosive to metals in the building. Cellulose comes as "loose fill" and can be poured by hand from the bag, but it is probably best applied when blown in with special equipment. *Mineral wool* includes both rock wool and glass fiber, and can be purchased in "batts" and "blankets" and also comes as loose fill. Batts are pre-cut pieces, usually several feet in length. Blankets are packaged in rolls of a variety of lengths. *Cellular plastic foams* include polystyrene, polyurethane, or urea formaldehyde (UF) and must also be treated for fire retardancy. Both polystyrene and polyurethane are sold in boards or sheets, while UF is installed as a wet foam by a contractor.

Question: What is the best type of insulation?

Answer: Selecting the right kind of insulation is very much an individual choice. First of all, some insulation is better for certain applications than others. For instance, loose fill may be called for in tough-to-reach places, especially where it can be blown in or applied by hand around obstructions. But you would not normally use loose fill to insulate your crawl space or unfinished basement ceiling. Here, batts or blankets of *rock* wool and glass fiber would be an appropriate insulation choice. On the other hand, those batts and blankets, while excellent for attics and ceilings, should be used in wall spaces only if they can be fit snugly, leaving little air space. Similarly, UF foam can be readily applied in wall cavities but should not be used in attics or other open areas since high temperatures and humidity can cause it to deteriorate. In many ways, buying insulation is like purchasing any other consumer product: Each type has its own advantages and disadvantages, and the buyer must decide which product best fits his own needs. Ask questions about each type.

Supply also may be a factor in your choice this year. With the huge demand for insulation in the last two winters, certain types of material—particularly glass fiber insulation—could be in short supply in your area.

Question: What does "R" value mean?

Answer: R value is a number which indicates the thermal resistance or ability of a material to decrease the flow of heat through the house shell. It is the single most important indicator of the effectiveness of insulation and should be used by the homeowner in deciding what to purchase. The higher the R value, the more effective the insulation in doing its job, no matter what the type or thickness of the material. Always rely on R value to tell how much insulation you are getting for your dollar. For your reference, here are some estimated R values for different insulation materials:

Product	Typical "R" value per inch (25.4 mm) of insulation*
Rock wool batts and blankets	3.1 to 3.6
Rock wool loose fill	2.7 to 3.2
Glass fiber batts and blankets	2.7 to 3.7
Glass fiber loose fill	2.1 to 2.4
Cellulose loose fill	3.1 to 3.7
Urea formaldehyde	4.1
Polystyrene (expanded)	4.0 to 5.26
Polyurethane	6.25

Question: How much insulation is enough? How much energy and money will I really save?

Answer: These questions must be answered differently for each homeowner. Your decision about

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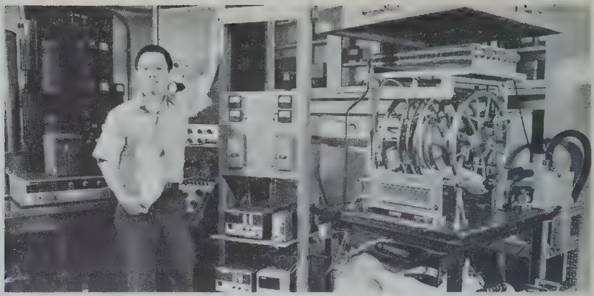
*Based on the American Society of Heating, Refrigerating and Air-Conditioning Engineers Fundamentals Volume *Guide and Data Book* and NBS research. Check the insulation packaging or ask your contractor for the R value of the specific insulation being used.



how much (how high an R value) insulation to add depends on the thermal effectiveness of your house right now, your local climate, and the kind of fuel you use. It also depends on the amount of money you are willing to spend, whether or not you will be borrowing the necessary funds, and how long you plan to live in your house.

For some people, an insulation job that will pay for itself through lower heating bills over 7 or 10 years or even longer is a worthwhile investment. Others demand a much quicker payback of even 1 or 2 years. If you compare your potential savings from upgrading the insulation in your house with the interest you would earn in the bank, you will likely end up adding insulation. Don't forget, the insulating you do now raises the resale value of your house and will make it more attractive to potential buyers.

Question: Does insulation present a fire hazard?

Answer: Properly produced and installed insulating materials will not pose any special fire hazards. However, if improperly manufactured or installed, insulation can present such a hazard. Here are a few tips researchers at NBS and elsewhere recommend to ensure a safe insulation job for your home:

—Ask the seller for written information about the insulation's fire retardancy. Although it is not generally required by law right now, the material should meet the latest specification set by the General Services Administration (GSA), which is used by the federal government when it buys insulation. The Consumer Product Safety Commission will soon be setting mandatory standards for all residential cellulosic insulation. It will be based on a GSA specification.

—When insulating between attic floor joists where there is no insulation now or where existing insulation is to be removed, place the vapor barriers which are attached to some mineral wool insulation downward, facing the interior ceiling. Vapor barriers should not be facing outward, exposed.

—If you are adding insulation, do not let it come into contact with recessed lighting fixtures (from ceiling lights on the level below) or other heat producing devices like furnaces, chimneys, or flues. Insulation should be kept 8 cm (about 3 inches) away from such heat sources to avoid smoldering or ignition of the insulation or the overheating of the fixture. When using loose fill, put up a barrier around such heat sources.

—When you add insulation near wires running across an attic floor, avoid covering the wires with insulation if possible. Preliminary research at NBS indicates that when wires are covered, the heat build-up can cause wire temperatures to exceed the safety levels currently specified in the National Electrical Code.

—If you notice wiring which is cracked, frayed, or otherwise faulty, have repairs made by a qualified electrician before adding insulation. (Knowledgeable handymen who undertake their own adjustments should always exercise extreme caution in handling the electrical repairs.)

—Polyurethane and polystyrene sheets should be covered by a more fire resistant material, like gypsum board.

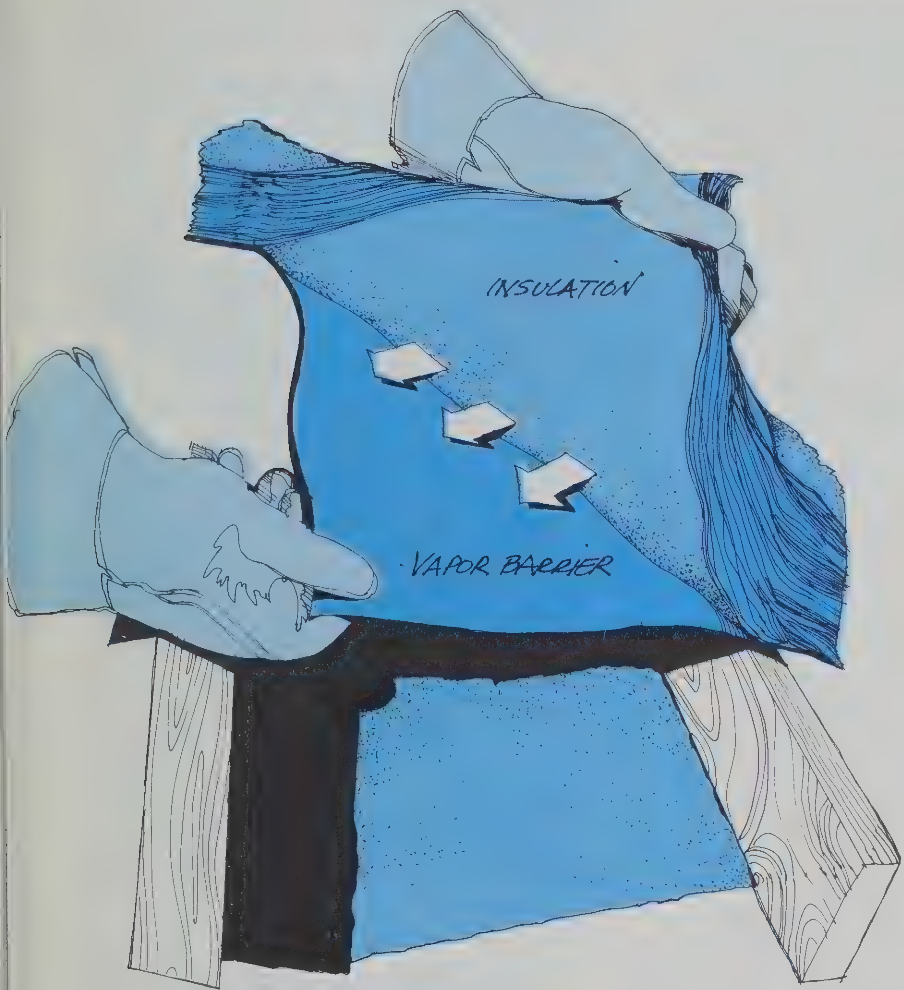
—If you are having insulation blown into your walls, make sure that after the contractor is finished *he shuts off the power* and then clears the insulation material from electrical wall outlet boxes.

Question: What does a vapor barrier do, and should I have one?

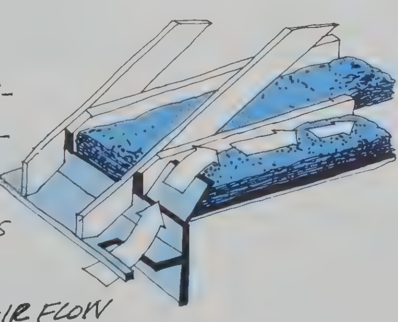
Answer: A vapor barrier is typically a layer of asphalt-impregnated paper, aluminum foil, or plastic needed to prevent moisture within the house from entering the space beyond the interior wall and ceiling areas, especially in colder parts of the country. Mineral wool batts or blankets can be purchased with attached paper or foil backing that serves as a vapor barrier. When loose fill insulation is used, plastic sheets can serve as a vapor barrier. Vapor resistant paints on interior surfaces can also work as a vapor barrier by preventing moisture from leaving the living area.

When you are adding insulation, check to make sure that the original insulation already has a vapor barrier and that it is properly placed, closest to the "winter-warm" side of interior walls and ceilings. In the attic, for example, the vapor barrier should face down with the insulating material above it. If you discover that there is no vapor barrier or that it is improperly installed, take *one* of the following actions: Re-do the initial installation, provide excess ventilation in the attic and remove or slash improperly installed vapor barriers, or paint the ceiling with an aluminum-based paint or with two coats of

NBS Engineer Chock Siu shows a newly constructed guarded hot plate. This device will enable NBS to provide manufacturers and testing laboratories with standard reference materials for calibrating their own equipment, thus allowing them to measure the R value of thicker insulation materials.



IF YOU BUY INSULATION WITH A VAPOR BARRIER ATTACHED TO SUPPLEMENT EXISTING INSULATION, REMOVE THE VAPOR BARRIER BY PEELING IT AWAY. THIS WILL PREVENT MOISTURE ENTRAPMENT AND MAINTAIN INSULATION EFFICIENCY.



INSTALL BAFFLES AT THE INSIDE OF THE EAVE VENTS SO THAT THE INSULATION WON'T BLOCK AIR FLOW FROM THE VENTS INTO THE ATTIC. BE SURE THAT INSULATION EXTENDS OUT FAR ENOUGH TO COVER THE TOP PLATE.

an oil-based paint. If you have insulation already in place in your attic, never install a vapor barrier over the existing insulation. Either buy unfaced insulation or strip the vapor barrier off the insulation you are adding.

Proper placement of vapor barriers is important in the walls as well. If you are adding insulation to the wall space, make sure that the vapor barrier is placed on the winter-warm side. (Here, too, a vapor resistant paint applied to the interior walls is an option you may wish to consider if you have difficulty installing a vapor barrier.) It is important that the wall insulation be allowed to "breathe" through the exterior of your house to prevent moisture build-up and the possible peeling and blistering of paint. This can be achieved by providing rain-proof vents in the siding. Be sure to check these details before you or a contractor adds wall insulation.

Question: Should I plug up the attic vents during winter months to keep the cold air from entering the attic?

Answer: Definitely not. A certain amount of ventilation is needed in the attic to prevent moisture from building up and condensing in that area. This moisture could make your insulation less effective and, in some cases, could even cause paint to peel or wood to rot. Moreover, when adding insulation, be sure not to block up the eave soffit vents where the roof meets the sidewall. Use some form of rigid blocking to prevent loose fill from covering the vents' air passages to the attic space.

In fact, you should take a close look at whether your attic is now properly ventilated. If you have attic insulation with a vapor barrier or if half of your attic ventilation is near the roof and the other half is in the lower part of the attic, you should have about 0.1 square meter (1 square foot) of free ventilation area for each 30 square meters (300 square feet) of attic space. If you do not have a vapor barrier in your attic or if your vents are mostly at one level, use twice as much ventilation.

Question: Do I need to take any special precautions, such as protective clothing, when installing insulation?

Answer: Yes. Wear a dust mask and goggles to protect your eyes and lungs from particulate matter

turn page

which will be stirred up during installation. Also, wear gloves and a long-sleeved shirt to prevent possible skin irritation when handling glass fiber insulation. In the attic, try to wear some kind of hard hat to protect against injury from protruding nails in the roof or from rafters and trusses you might bump into. Use sturdy planks to stand or kneel on. To avoid creating a fire risk, don't ever smoke in your attic and be extremely cautious if soldering or welding must be done in the attic area, basement, or crawl space.

Perhaps you can rest a bit easier now when mulling over your own insulation situation. But there are still questions which must be more completely answered. The National Bureau of Standards and the Department of Energy (DOE) have jointly drafted a research plan designed to fill many of the gaps in our basic knowledge about insulation. That plan currently calls for a comprehensive, 5-year attack on a number of the uncertainties which have come to light. The goal is to get a better grasp on the effectiveness, durability, and safety of individual insulation materials and their uses in buildings.

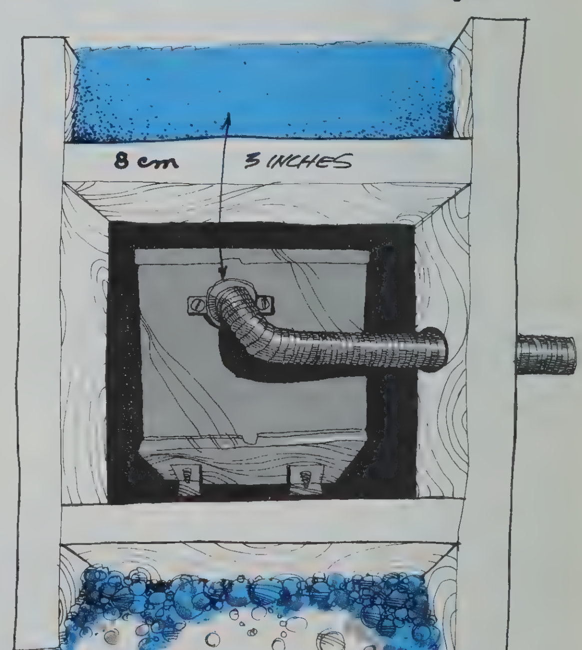
In order to accomplish this task, new technical data, test procedures, and standards are vital. Some of the necessary research is already under way at NBS and other laboratories, and significant new studies will begin in the near future.

For instance, with insulation being applied in greater thicknesses than ever before, new and improved ways to measure the thermal resistance of materials up to 35 cm (14 inches) thick are needed. NBS is currently working on this problem.

Improved laboratory methods are needed to measure the fire properties of insulation to ensure adequate fire protection is provided. Scientists and engineers at NBS have already done a considerable amount of work in this area and have devised two test methods which recently have been adopted for use in federal procurement of insulation. NBS researchers are particularly interested in determining the resistance to the spread of flame and smoldering which insulation exhibits singly and in combination with other building components.

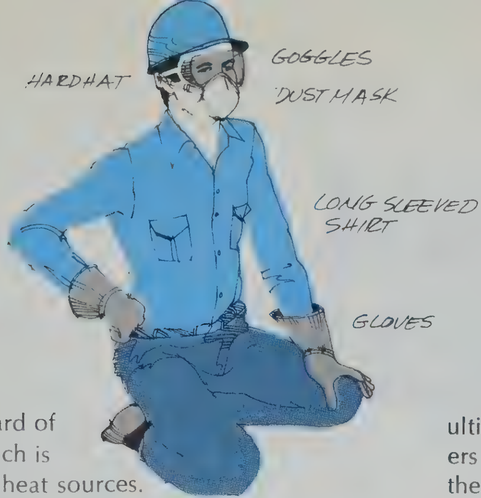
Testing at NBS laboratories has indicated that heating of electrical wires to temperatures above currently accepted code levels can result if wires are sandwiched between thick layers of insulation. Follow-up research sponsored by DOE is being conducted to learn more about this phenomenon. Studies are also being conducted to quantify the

WRONG! NEVER COVER RECESSED LIGHT FIXTURES! CHECK ALSO, TO SEE THAT YOUR EXISTING INSULATION IS NOT IN CONTACT OR TOO CLOSE TO A FIXTURE.



RIGHT!

ALWAYS LEAVE ATLEAST 3" BETWEEN THE INSULATION AND HEAT SOURCES LIKE LIGHT FIXTURES. WHEN USING LOOSE FILL, PUT UP A BARRIER AROUND HEAT-PRODUCING DEVICES LIKE LIGHT FIXTURES.



potential hazard of insulation which is installed near heat sources.

A research project by DOE examined existing insulation in a sample of Minnesota homes to determine how the materials fared after a number of years. No serious problems turned up. But more information about the effectiveness of insulation over a period of time is needed.

In fact, according to the DOE/NBS draft of a national research plan for insulation, perhaps the most difficult task relating to insulation materials research is determining durability and the effects of aging. Accordingly, measurement methods and performance data are needed for assessing settling, shrinkage, and warping of materials and possible changes in effectiveness.

Among other projects in this area, NBS is carrying out field studies of insulation already in place in the northeast, southeast, and mid-Atlantic states to look for settling, shrinking, moisture, deterioration, and the movement or leaching of fire retardants. NBS is also looking at the shrinkage and degradation problems UF foams have developed under the temperature and humidity extremes likely to occur in walls and attics.

Other materials present different difficulties. Certain flame retarding chemicals used in treating insulation are known to be potentially corrosive. The DOE/NBS research agenda concludes that the available tests to determine such corrosive effects are inadequate. NBS researchers are examining test methods and specifications for the proper use of insulation and flame retardants. They are also studying ways to minimize the corrosion caused by some chemicals.

Insulation does not function alone. Just as the homeowner has to consider other areas of his home where energy can be wasted, researchers must study the thermal properties of entire floors, walls, doors, windows, and roofs and ceilings. To help perform these studies, "hot boxes" large enough to hold wall and ceiling/floor sections are being designed and constructed for use by NBS. Furthermore, the information which comes out of the insulation work of NBS and other agencies will be useful in conjunction with energy conservation performance standards for whole buildings.

In one way or another, the results of such research eventually benefit the prospective insulation purchaser. More sophisticated test methods lead to greater accuracy and consistency in research and ultimately in the production of insulation. Researchers can then better predict and provide data on the thermal effectiveness and fire safety of particular types of insulation, and manufacturers can get a better handle on the products they are making. The new test methods and data generated from the research will also enhance the protection offered by standards, whether industrial or governmental, voluntary or mandatory.

To improve confidence in the tests performed on insulation materials—and thus the final product—the federal government is taking several steps. NBS is now developing new Standard Reference Materials for laboratories to use in calibrating their measurement procedures. These materials will cover a host of insulation properties.

In addition, the Commerce Department is developing a national voluntary program to accredit laboratories which test thermal insulation materials. With the technical assistance of NBS, the program will evaluate participating testing laboratories and accredit those which are judged capable of conducting specific tests. The program is scheduled to be underway by early 1979.

Another Commerce Department program will be more visible to homeowners. Aware of the confusion which surrounds the purchase of insulation for many people, the Commerce Department has developed a proposed uniform label to disclose information about insulation and to be placed on individual packages by manufacturers. Voluntary labeling by participating producers will give purchasers easily understandable information about the product at the point of sale. Facts about the insulation's fire characteristics, potential corrosiveness, and recommended applications would appear on the label. It would also show the insulation's R value and the area that could be covered by a package. If manufacturers can accept the proposal, labels will soon appear on packages of insulation.*

Obviously, figuring out what kind of insulation to use and where, when, and how to apply it is still no snap. But much is already known about this energy and dollar-saving material that can help a homeowner make a tough decision, and more help is on the way. □

*The Federal Trade Commission has been working on a labeling requirement which would make showing the R value and area covered by a package mandatory; the Commerce Department label will include the same information where possible.

THE NATIONAL MEASUREMENT SYSTEM

Meeting Requirements for Essential Services

by Lucy Hagan and Ann Whitmore

YOU seldom notice your own breathing—unless there is a problem with the system that supports this critical function. What breathing is to the body, measurement is to civilization. And behind every act involving physical measurement in this nation—from checking the time to trying to determine the speed of light with greater accuracy—there is a support system that tracks back to a single organization—the National Bureau of Standards.

To NBS, measurement is a service. It is necessary to all forms of commerce. It is required in the production of goods for mass consumption and the assurance of their quality. It is essential to the production and delivery of other services, for example, health care, communications, and transportation.

To an increasing extent, measurement is a service necessary for protecting the environment and the safety of the public. Such service is generated and delivered by those who buy and sell; by those who operate machines, control processes, and inspect results; and by those who enforce and comply with regulations.

Their tools are instruments in one form or another. Measurements are required, to various degrees depending upon the particular situation, to be accurate in the sense that they conform to accepted standards. They are also required, to various degrees, to be precise in the sense that the same results can be obtained time after time.

Dr. Arthur O. McCoubrey, associate director for Measurement Services in the NBS National Measurement Laboratory, recently reviewed and analyzed the findings of the NBS National Measurement System Project. This project resulted in the publication of 24 impact studies of NBS measurement programs and five summary reports.[1] He concluded:

"For many years now, following the ideas suggested by Dr. R. D. Huntoon,[2] we have attempted to describe measurements in terms of the functions of a vast system of interrelated institutions, people, machines, and tools. The concept of a National Measurement System has an appeal because it tends to unify something which is otherwise very difficult to comprehend. But it is a concept which is often elusive and intangible when we try to describe the details at a microscopic level.

"Perhaps, from a practical viewpoint, it is more useful to limit the concept of a system to that aspect of measurements which makes it possible to realize *accuracy,* that is, all of the provisions which make it possible to refer measurements to accepted standards. The processes involved in the reference of measurements to standards are generally embraced by the term traceability. Thus, we might well be concerned with our *National Measurement Traceability System* and its adequacy to meet all of our requirements for measurement services."

Hagan is scientific assistant to the Director, NML. Whitmore is physical science aide at NBS while on a field term from Beloit College in Wisconsin.

1. "Final Summary Report Study of the National Measurement System, 1972-1975," R. C. Sangster, NBSIR 75-925, 40 pages (Dec. 1976). This report contains references to all of the studies.
2. R. D. Huntoon, "Concept of a National Measurement System," Science *158,* 67-71 (Oct. 1967).

The NBS study of the National Measurement System (NMS), begun in 1972, addressed the following questions:

- What is the present status of NBS measurement services in meeting user needs?
- What are the current trends in user needs for NBS services?
- What future needs for NBS services can be anticipated?

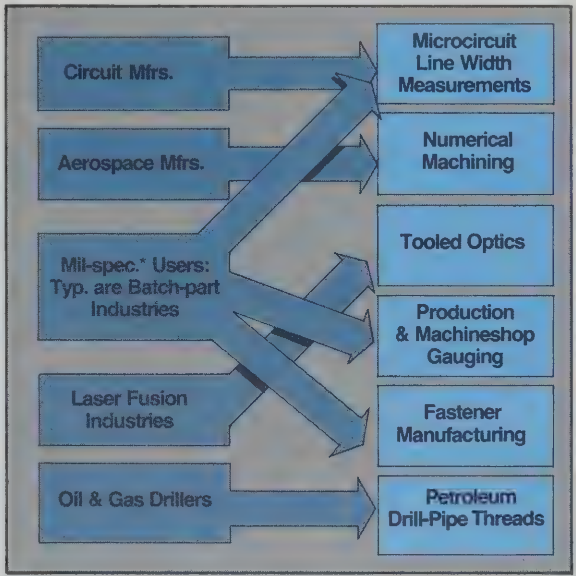
To answer these questions NBS organized a series of studies of specific aspects of the system. The studies included NBS activities involving six of the base units of the international system (SI)—length, mass, time, electric current, temperature, and luminous intensity—as well as frequently used units derived from these base units.

Sources of information were selected for study based on analyses of NBS clientele, the instrumentation industry, membership of the National Conference of Standards Laboratories, Standard Industrial Classification codes, and various statistical reports. Workshops and conferences where held with the technical representatives of the specific areas within NMS being studied. Other contacts were made through correspondence, questionnaires, and intercomparisons of standards. The possibility of doing an economic analysis of the NMS was reviewed.

As a result of these studies a representation of the interactions of NBS within the NMS has been developed by induction from the information obtained from the various reports. The conceptual system defines the measurement quantities and units based upon invariant natural phenomena or physical prototypes, such as the kilogram, which is intercompared with the international kilogram to establish agreement. For the base SI units the kilogram is the only unit now maintained by a system of prototypes.

For each technical area studied it was possible to describe how NBS actions affect users' problems in physical measurements in a series of interaction diagrams or NBS impact charts. These charts were developed by Dr. Howland Fowler of the National Engineering Laboratory, who worked with the managers of the program areas studied, and developed interaction diagrams specifically describing each of these areas. The interaction diagrams are described in terms of five hierarchical levels:

1) Field Problems—measurement problems as users see them.



2) Users—identified user groups with an economic, health, or safety-related stake in the solution of the problem.
3) Measurement Dissemination System (or Hierarchy)—The system is described by diagrams showing the flow of instruments and services, from instrument manufacturers to measurement laboratories. Also shown are NBS impacts, such as calibration services, measurement assurance programs, standard reference materials, and maintenance of the base standards.
4) Voluntary or Documentary System—The System is described by diagrams showing user group interactions, through industrial and professional associations and standards writing

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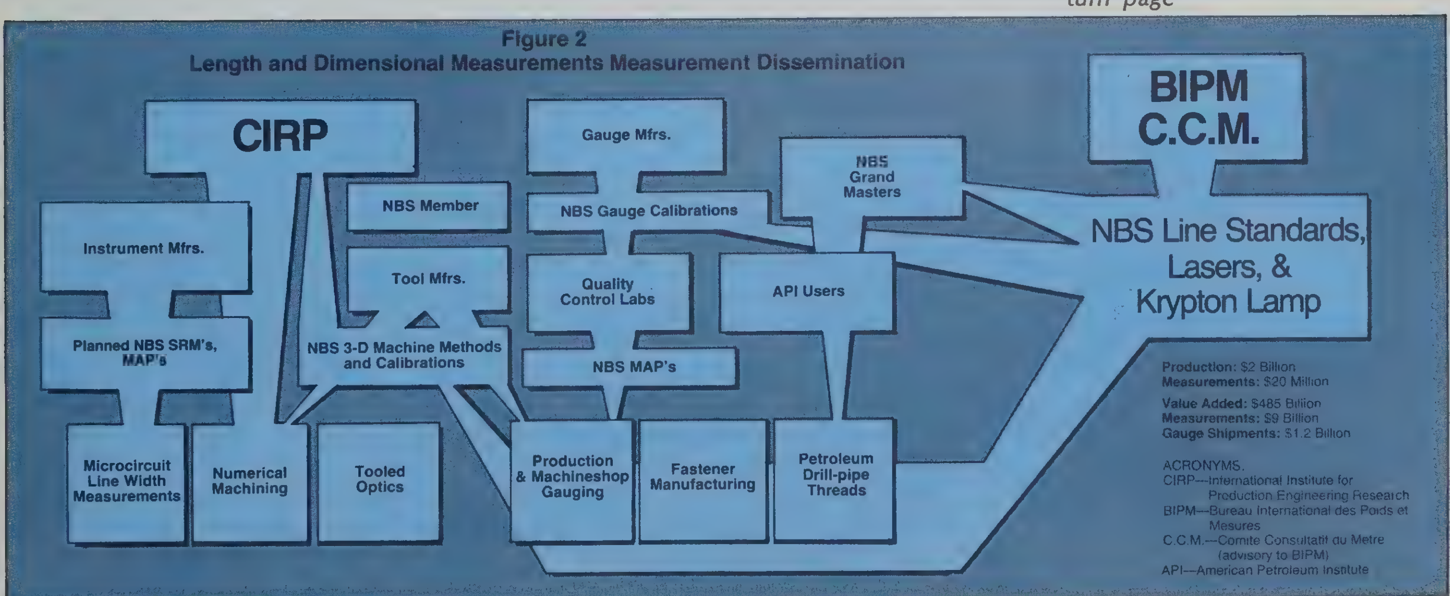

Figure 2
Length and Dimensional Measurements Measurement Dissemination

groups. The outputs from these flow to international bodies, or they are adopted by regulatory agencies. NBS has considerable activity within this system.

5) Regulatory or Mandatory System—The system is described by diagrams which show the relationship of regulatory agencies to the problems which they regulate, or the relationship of mandatory control groups to the areas in

Figure 3 — SI Base Units

Quantity	Name	Symbol
Length	meter	m
Mass	kilogram	kg
Time	second	s
Electric current	ampere	A
Thermodynamic Temperature	Kelvin	K
Luminous Intensity	candela	cd

HIGHLIGHTS OF THE NMS STUDY

The results are highlighted for each of the SI base units studied. Specific trends and future needs are noted.

Time and Frequency

- NBS programs provide for the system:
  —Realization of the fundamental unit of time, the second, with an accuracy of 1 part in 10^{13}. One second is defined by international agreement as the duration of 9 192 631 770 cycles of the radiation corresponding to the transition between two hyperfine levels of the ground state of the cesium isotope, ^{133}Cs.
  —Time and frequency dissemination services through radio stations WWV and WWVB in Fort Collins, Colorado, and WWVH in Hawaii and supplementary services utilizing TV network signals and telephone access to the radio signals.
- Current trends in user needs within the system:
  —Increased use of frequency equalization services at accuracies of 1 part in 10^{8} by telephone and television industries, standards laboratories and electric power companies.
  —Public demand for a more widespread time calibration accurate to about 0.1 second to adjust and set quartz watches. NBS has the technical capability to meet both of these user needs.
- Future interest in this system includes satellite time broadcast services to achieve more uniform coverage at higher accuracies necessary for communications, position finding, and various defense-related applications.

Length

- NBS programs provide for the system:
  —Realization of the fundamental unit of length, the meter, with an accuracy of 5 parts in 10^{9}. The meter is defined as 1 650 763.73 wavelengths in vacuum of light resulting from the atomic energy level transition of an isotope of krypton, ^{86}Kr. The unit is now realized by de facto standards based on wavelengths of saturated absorption lines of iodine or of methane produced by helium-neon lasers. These lines are reproducible with an uncertainty of the order of 1 in 10^{10}; the value of their wavelength in meters is subject to the uncertainty of the standard.
  —Length dissemination services include calibrations of dimensional reference standards using mechanical, optical, and electronic instrumentation and width measuring machines.
- Current trends in user needs within the system:
  —Include increased demands for automated multidimensional calibrations to which NBS has responded by adapting standard calibrations to a three-dimensional measurement facility.
- Future needs in this system are in the field of simultaneous multi-dimensional linear measurements, such as those associated with complex computer-controlled machine tools and with the production of intricate, finely detailed masks for integrated circuit manufacture.

Mass

- NBS programs provide for the system:
  —Realization of the base unit, the kilogram, with an accuracy of 3 parts in 10^{9}. The mass of the NBS kilogram is determined by comparison of the NBS prototype with the international standard kilogram maintained at the Bureau International des Poids et Mesures (BIPM) in France.
  —Mass dissemination services are provided through the NBS Office of Weights and Measures, which disseminates sets of mass standards to the states.
- Current trends in user needs within the system:
  —Mass measurements for accountability of fissionable materials is the most urgent need at the present.
- Future opportunity for a more reliable and cost effective way to transfer mass:
  —Development of an absolute density scale based on single crystal silicon density artifacts. Water, the present absolute density standard, presents difficulties for various reasons, including variations in isotopic composition.
  —Development of systems standards and measurement techniques for dynamic force to make possible accurate measurements in such diverse fields as the metal-forming industry, in-motion weighing operations, and impact-testing and load-carrying systems.

which work is impermissible without their sanction. NBS functions needed for implementation or compliance are highlighted.

Thus, the total NBS impact for any technical area is the sum of all the interaction diagrams or NBS impact charts for the Measurement, Voluntary, and Regulatory charts. An example of two of these charts for measurement dissemination of length and dimensional measurements are shown in Figures 1 and 2. The box below contains highlights from the full study.

The study also revealed needs for traceability to national standards in the case of many complex derived units used in industry. Dr. McCoubrey pointed out: "This result highlights the importance of increasing institutional capabilities outside of NBS, particularly in the area of engineering metrology." □

Temperature

- NBS programs provide for the system:
  —Realization of the base unit for temperature, the kelvin, with an accuracy of 1 part in 10^6. The kelvin is defined as 1/273.16 of the thermodynamic temperature of the triple point of water.
  —Temperature dissemination services include calibrations of thermometry equipment owned by governmental and industrial laboratories and distribution of standard reference materials which are called temperature fixed points because of the high accuracy and reproducibility at which these materials melt and freeze, thus making them useful calibration points.
- Current trends in user needs within the system:
  —Use of electronic thermometers and thermistors in the medical field has created need to determine the relatively unknown characteristics of these devices.
- Future needs in the system include:
  —Development of temperature measurement capabilities in hostile, extremely high-or-low temperature environments needed for development of new sources of energy such as superconductive power transmission, geothermal sources, nuclear reactors, controlled thermonuclear reactors, and solar power plants.

Electricity

- NBS programs provide for the system:
  —Realization of the base unit, the ampere, with an accuracy of 1 part in 10^7. The ampere is defined as that constant current which, if maintained in two straight parallel conductors of infinite length, of negligible circular cross section, and placed 1 meter apart in vacuum, would produce between these conductors a force equal to 2×10^{-7} newton per meter of length.
  —Electricity dissemination services include calibration services for electrical measuring instruments, such as watt-hour meters, and measurement assurance programs for measurement of voltage, inductance, and energy.
- Current trends in user needs within the system:
  —New or higher-accuracy measurements in such areas as dielectric hysteresis, phase differences, power, non-sinusoidal high-crest-factor signals, and reduction of alternating current (AC) calibration uncertainties to 10 parts per million.
  —Series of tutorial publications covering various aspects of electrical metrology useful to personnel of standards and calibration laboratories in industries and in other government agencies.
- Future needs identified by the NBS study are for standards and measurement methods associated with high speed measurements of electrical parameters in electrical systems such as computers, in-process probing of integrated circuitry during manufacture, and of impulse noise in systems.

Radiation

- NBS programs provide for the system:
  —Highly accurate realization of radiance and irradiance units for the entire spectral range from the infrared to the far ultraviolet, and the most accurately calibrated detectors for this spectral range.
  —The most accurately calibrated detectors for ionizing (nuclear) radiation.
  —Radiation dissemination services include calibration of users' sources of radiation and detectors of radiation (ionizing and non-ionizing) and measurement assurance programs, both for ionizing and non-ionizing radiation, for the user to measure in his own system the amount of radiation present in the geometry of his special application.
- Current trends in user needs within the system:
  —A new photometric standard based on radiometry to replace the blackbody standard and improve measurements of many new light sources for which there is no agreed upon standard in the lamp industry.
  —Development of new spectral and detector standards and of transfer standards.
- Future needs in the NMS system are for radiometry measurement to 1 percent accuracy to meet accuracy requirements for measurement of solar radiation. Also needed are portable transfer standard systems for making radiation measurements, for ionizing radiation measurements in nuclear reactors, and for an extended system of radioactivity quality control throughout the 10 800 institutions dealing with nuclear medicine.

NUCLEAR SAFEGUARDS AND NBS

by David Chaffee

As the use of nuclear energy has expanded, there has been a corresponding worldwide effort to keep account of nuclear materials to assure that they are not being diverted from their intended applications. The Nuclear Regulatory Commission (NRC) monitors private plants in the United States and the Department of Energy (DOE) regulates certain U.S. government-owned installations. In addition, the International Atomic Energy Agency monitors compliance to the Nuclear Non-Proliferation Treaty that has been signed by over 100 nations.

Yet, all of the organizations have had difficulty measuring radioactive gases, liquids, and solids used for nuclear energy. A 1974 study by the National Bureau of Standards, "Assessment of the Nuclear Fuel Materials Measurement System," spells out the need for a comprehensive measurement system for such substances.

In order to satisfy this need, NRC, DOE, and NBS have developed a standardization program for nuclear safeguards measurements. According to the program proposal, "NBS is the government organization with the primary responsibility for providing the nation's reference measurements and standards services. The capability for NBS to fulfill an expanded role in nuclear materials control and accounting is based on a long involvement in the nuclear program. The Bureau supplies Standard Reference Materials (SRM's) for plutonium and uranium, provides some basic nuclear reference data, and maintains a broad program of expertise in basic metrology, chemical analysis, isotopic analysis, and statistical analysis."

Chaffee is a staff writer in the NBS Public Information Division.

This proposal has paved the way for major NBS involvement. The NRC, DOE, and the State Department are providing a total of $2 million a year for the NBS effort.

"The bottom line in making sure you are safeguarding nuclear materials is to keep an accurate inventory," says Dr. Thomas Yolken, chief of the NBS Office of Measurements for Nuclear Safeguards. "We at NBS can do much to improve measurement methods and standards for this purpose."

Current measurement methods in this area are intended to disclose the extent of "inventory difference," a calculation that is made on all nuclear material at every stage from production to final use and then through recycling. It is arrived at by taking the beginning inventory in a plant, adding to it all inputs into the plant, and then subtracting all outflows (including scrap, waste, and product). The result is then compared to the ending inventory and the difference between the two is the inventory difference. This difference can be caused by measurement uncertainty or actual loss of material. The accuracy of the measurements used to calculate inventory difference are crucial —particularly for plants where enriched uranium and plutonium are most prevalent.

Since October 1975, NBS has been examining the nuclear power cycle to find out how to make such measurements more easily and more accurately. Emphasis is on four measurement areas: (1) destructive chemical and isotopic analysis —taking a sample of nuclear material during processing and chemically analyzing the fissionable components. The sample is destroyed in the process; (2) nondestructive assay—a rapid measurement technique which utilizes either gamma or neutron spectrometry or calorimetry. The method does not destroy the sample and the measurement can be made right on the production line in many cases; (3) bulk measurements—better calibration of the measurements to determine mass, volume, and density of nuclear materials; and (4) statistics—fostering the correct application of statistics and sampling to improve the validity of the overall measurement results.

The work at NBS is carried out in a number of centers. In the Center for Mechanical Engineering and Process Technology, a group of researchers is improving techniques used to determine the mass of cylinders used in transporting nuclear materials, and the volume of tanks used in housing them at plants to see how the amount of nuclear material contained in them can be better determined. The researchers have improved the calibration accuracy of nuclear materials accountability tanks so that measurements will be from 10 to 100 times more accurate. Efforts are also underway to improve the pneumatic bubbler tubes which are used in the measurement of the amount of material in such tanks at a given time.

Scientists in the Center for Thermodynamics and Molecular Science are trying to evaluate the performance of pressure transducers, which might be used in the calibration of the accountability tanks. In addition, they are working to improve the standardization of calorimetry measurements used to determine the amount of plutonium in a sample. The Center for Absolute Physical Quantities is doing a feasibility study on whether infrared thermography can be used as an adjunct to gamma ray detection in locating nuclear material residue that accumulates in pipes and other areas.

Within the Center for Analytical Chemistry, researchers are developing a series of nuclear Standard Reference Materials so that current calibration methods can be better judged. The center is also involved in developing the first international standards for the nondestructive assay of nuclear materials and is trying to find better ways of calibrating instruments used in nondestructive assay. This work is being carried out in cooperation with the Commission of the European Communities.

The Center for Radiation Research has completed a determination of the half-

life of Plutonium-239 and is preparing for half-life measurements of Plutonium-240 and Plutonium-241 in the near future.

The Center for Materials Science and the Center for Radiation Research are developing resonance neutron radiography, an imaging technique by which radioactive materials are calibrated by isotopic photographs. Results could lead to greater accuracy both in characterizing reference materials and in measuring already used materials that are headed for reprocessing.

The Center for Applied Mathematics is now working and will continue to work with the other centers in helping them design measurement collection methods and better analyze data.

NBS' strong involvement in the nuclear safeguards program will continue, predicts Yolken, until accurate measurement methods have been developed that will quickly thwart any efforts to divert nuclear material. He hopes this can be accomplished in the next six or seven years.

A NEW MEASUREMENT CONCEPT FOR THE ELECTRONICS INDUSTRY

by Collier Smith

Scientists in the National Bureau of Standards' Electromagnetic Technology Division in Boulder, Colorado, are applying a new measurement concept to simplify and improve the accuracy of calibrations and measurements of high frequency and microwave circuit parameters. Such parameters include voltage, current, power, impedance or reflection coefficient, and scattering. This new idea, called the six-port concept, holds that a wide range of arbitrary (non-ideal) linear circuits with six ports or terminal pairs can be used to measure circuit parameters at one of the ports in terms of power readings taken at four of the other ports. (The rf signal is applied for the remaining port.)

Interest in the six-port concept is spreading rapidly through the electronics industry. A half-day session at the Microwave Theory and Techniques Symposium in San Diego last year attracted a standing-room-only crowd to hear six papers presented by individuals from NBS and industry on the first applications of the six ports. As a result of this and other meetings and recent articles in trade journals, an increasing number of companies and researchers are showing active interest in the new technology.

For example, Dr. Ross A. Speciale, an electrical engineer from TRW in Redondo Beach, California, has become a Research Associate* at NBS-Boulder with the intent of acquiring practical six-port experience for his company. "It is my task to cooperate with NBS scientists in trying to forward the state-of-the-art," says Speciale. "After returning to TRW, I will continue the research and design effort while building a KU-band six-port pilot system for in-house power, phase, and reflection coefficient measurements and for power meter calibrations."

The six-port concept was developed by electronics engineer Cletus Hoer and Dr. Glenn Engen, senior scientist, both in the Electromagnetic Technology Division at the NBS-Boulder Laboratories. In the course of their work on the idea, they found that it had several other advantages besides good accuracy. The six-port can be used over a broad range of frequencies without manual adjustment, and it has a useful dynamic range of 50 dB, even if the power detectors used have a range of only 30 dB. It is ideally suited for automated measurements, which means a device can be calibrated at hundreds of different frequencies and power levels in the time needed for only a few manual measurements.

Several six-port instruments have been put into service at NBS and other laboratories. For example, the Air Force's School of Aerospace Medicine at Brooks AFB, Texas, is using a six-port microwave vector voltmeter to measure the change in attenuation and phase through a test enclosure when animals are placed in the enclosure. This information can help determine safe levels of microwave radiation from 0.5 to 10 GHz.

At NBS, most microwave power calibrations are performed with an automated six-port reflectometer. The most recent application of the six-port concept is in measuring all of the network parameters of any two-port device by inserting the two-port between six-port reflectometers. The parameters that can be measured with this setup include attenuation and phase change through passive devices or gain, isolation, and phase change through active devices.

Smith is a public information specialist in the NBS Program Information Office, Boulder, Colorado.

* The Research Associate Program, a plan which has been in operation for over 50 years, enables engineers and scientists from companies and trade and professional organizations to work at NBS for specified periods of time on projects of mutual interest to their sponsoring organizations and NBS. For information, contact: P. R. deBruyn, Industrial Liaison Officer, A402 Administration Building, NBS, Washington, D.C. 20234, 301/921-3591.

STAFF REPORTS

PROGRAM ON MIGRATION BEHAVIOR OF PLASTIC FOOD-PACKAGING MATERIALS

A program is underway at the National Bureau of Standards to develop and experimentally validate physical modeling methods that describe the migration of additives from plastic packaging materials to food. The project is supported by the Food and Drug Administration.

Leslie Smith, Polymer Science and Standards Division, B318 Polymers Building, 301/921-3321.

Plastic food packaging materials help give the U.S. the lowest food spoilage rate in the world. Polyethylene milk bottles, polyvinyl chloride meat wrap, polystyrene egg cartons, and polyester carbonated beverage bottles are only a few of the more familiar examples. Unfortunately, these materials and products also introduce the possibility of contamination from harmful substances which may be present in any packaging material.

The federal responsibility for public safety in this regard lies with the Food and Drug Administration (FDA), which regulates the use of all materials which come into contact with food. The FDA regulations are administered on a case by case basis: Data on the extraction of substances from packaging materials by food-simulating solvents are gathered and used in combination with conventianal animal feeding trials, when indicated. This empirical approach was adequate to cope with a small number of food contact materials, but has become very inefficient in the presence of the wide variety of plastic packaging products which have appeared in recent years.

Typical commercial plastics contain a number of low molecular weight additives that develop or maintain particular properties in the plastic, and the tendency of each of these additives to migrate from the packaging to the food must be considered. The number of possible combinations of plastic and additives is enormous, and this requires a commensurate volume of empirical data to be gathered and evaluated. Any change in the industrial process—a different processing temperature, for example—might also require a complete set of additional data. The current regulatory system is inflexible, is costly for industry to satisfy and for the government to administer, and stifles innovation by introducing long lead times and uncertainties into the clearance procedure.

With the support of the FDA, we in the Polymer Science and Standards Division have recently begun work on the development of general physical models that can describe the migration of low molecular weight substances from plastic packaging materials. This work combines the development of new theoretical approaches to such models with the direct measurement of diffusion by several different experimental methods.

The initial phase of the project will concentrate on polyethylene, the most widely used plastic packaging material. Polyethylene terephthalate and polystyrene will be treated in subsequent phases of the program. Trial models which predict the equilibrium partitioning of an additive between the packaging material and food-simulating solvent are now being evaluated against existing data and will be further tested using radiolabeled additives in laboratory experiments.

These physical models will be used by FDA in planned revisions of packaging regulations to organize and classify materials on the basis of their migration behavior. The models will also be used by toxicologists to set priorities for screening tests and by public health administrators in evaluating public health policy in regard to the rapidly evolving packaging technology.

The general principles of additive migration have application to several other important problems. These include migration from synthetic implant materials and life-time limits of polymer durability caused by migration of protective additives.

TOWARD A NEW SCALE OF TEMPERATURE

The International Consultative Committee on Thermometry has taken several actions of importance to scientific and industrial thermometrists.*

James F. Schooley, Temperature Measurements and Standards Division, B130 Physics Building, 301/921-3315.

The International Consultative Committee on Thermometry, which currently meets every two years at the International Bureau of Weights and Measures near Paris in order to advise the International

**The International Consultative Committee on Thermometry is an organization under the Treaty of the Meter. The Treaty in 1875 established the General Conference on Weights and Measures whose member nations develop and maintain international measurement standards and the corresponding system of units. An International Committee for Weights and Measures is responsible for administrative and technical matters between Conference meetings and proposes actions for consideration by the Conference. Consultative Committees assist the Weights and Measures Committee. Dr. R. P. Hudson, Deputy Director of the NBS Center for Absolute Physical Quantities, is the NBS delegate to the Consultative Committee for Thermometry, and Dr. Schooley attended the recent Consultative Committee meeting to provide additional technical detail.*

Committee for Weights and Measures regarding progress in the field of thermometry, addressed this year the timing of a new International Practical Temperature Scale, its makeup, and the means by which it can be made of greatest use to scientific and industrial thermometrists.

The Consultative Committee also put forth a provisional scale of temperature (called the EPT-76 from the initials of its title in French, the official language of the Consultative Committee), to improve the present International Scale below 30 K and to provide an international scale farther into the cryogenic range.

The need for a new scale is greatest at these very low temperatures, where the present scale does not reach to the temperature range in which the superconducting technologies important to several countries must operate, and also at very high temperatures, where the errors and inconsistencies in the present scale are causing increasingly noticeable deficiencies in thermometry. In the middle temperature range from −50 °C (−58 °F) to +400 °C (+752 °F), which is of most importance to the world's industrial and scientific thermometrists, present research indicates that the creation of a new temperature scale will have less effect on reference calibrations.

History of the International Temperature Scale

The present scale, the International Practical Temperature Scale of 1968, was recommended by the Consultative Committee on Thermometry to the International Committee for Weights and Measures during its 1967 meeting. In turn, the International Committee, having been authorized to do so by the 1967 General Conference, accepted and promulgated the new scale in 1968 to replace the 1948 scale. In the temperature range below 600 °C, the 1948 Scale incorporated only minor changes from the International Temperature Scale of 1927. (ITS-27 was the first scale to be adopted by a General Conference on Weights and Measures.) However, a major change was made in the evaluation of temperatures above the gold point (taken as 1063 °C in both scales). The ITS-27 had specified the Wien law for radiation thermometry

$$\frac{J_t}{J_{Au}} = \frac{\exp\ (C_2/1336\ \lambda)}{\exp\ (C_2/[t + 273]\ \lambda)}\ ;$$

it was regarded as valid for the range for which $[t + 273]\ \lambda$ was less than 0.3 cm degree. However, the ITS-48 introduced the Planck Law

$$\frac{J_t}{J_{Au}} = \frac{\exp\ (C_2/1336.15\ \lambda)\ -1}{\exp\ (C_2/[t + 273.15]\ \lambda)\ -1}\ .$$

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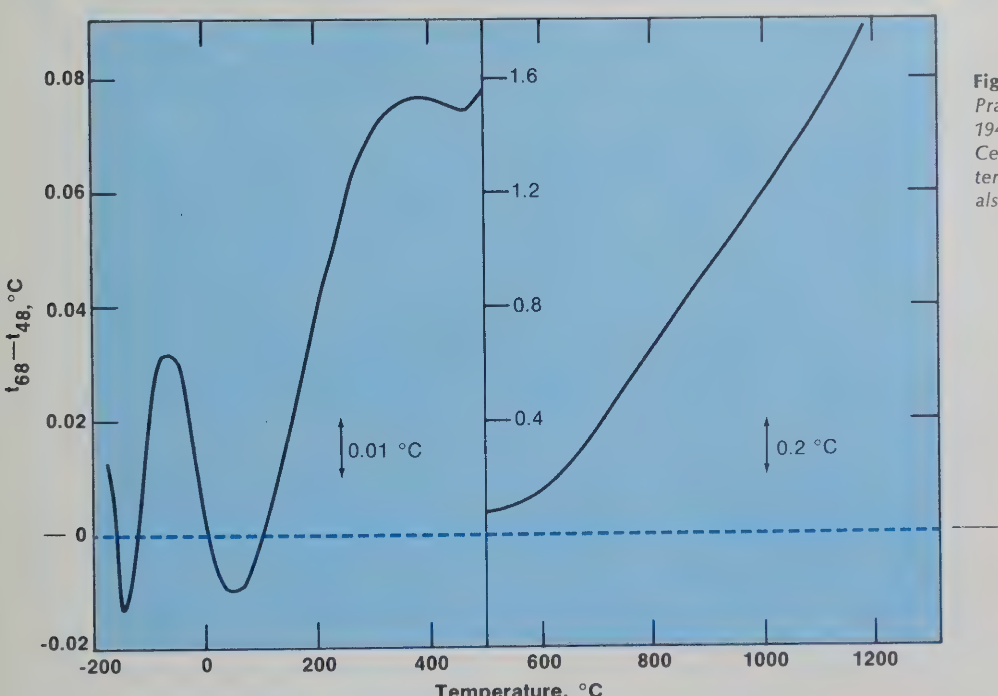

Figure 1—*Differences between the International Practical Temperature Scales of 1968 (t_{68}) and 1948 (t_{48}). Note that the lower case t is used for Celsius temperatures, while the capital T denotes temperature values expressed in kelvins. Note also the change of vertical scale at 500 °C.*

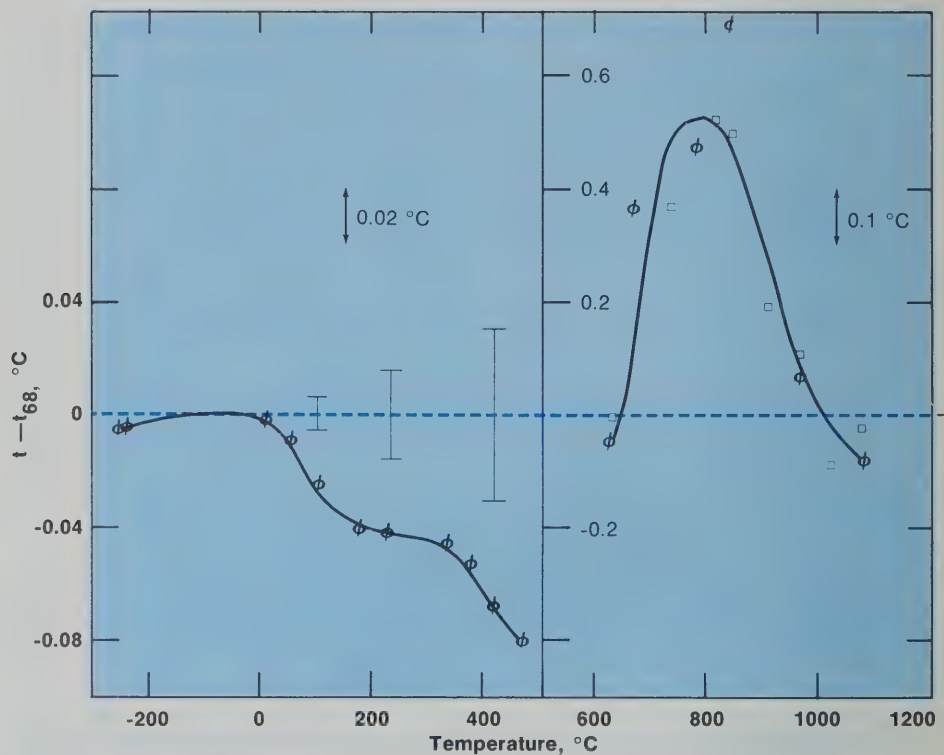

Figure 2—*Differences between Celsius thermodynamic temperatures (t) and the International Practical Temperature Scale of 1968 (t_{68}), as indicated by current thermometry research discussed in the text. Note the estimated thermodynamic uncertainty levels of the IPTS-68 at 100 °C, 232 °C, and 420 °C (from Table 7 of the Scale text.) Also note the change of vertical scale at 500 °C.*

Thus in the 1948 Scale the approximate upper limit of 4300 °C for the ITS-27 was eliminated, and a decrease of as much as 1 percent was introduced for temperature calibrations in the range 1100 °C to 4300 °C.

A rather confusing, and in retrospect humorous, feature of the 1948 scale revolves around its definition and nomenclature. The ambiguity which persists today regarding the use of the names "Celsius" and "Centigrade" arose during the period of time encompassing the writing of the scale by the Consultative Committee on Thermometry (this process began in 1939, but it was disrupted by World War II), its acceptance and promulgation by the Ninth General Conference on Weights and Measures in 1949, and its revision by the Eleventh General Conference in 1960.

During its 1948 meeting, the Consultative Committee noted that the triple point of water constitutes a more precise thermometric reference point than the melting point of ice; on the basis of this conclusion, it recommended "that the zero of the thermodynamic centigrade scale should be defined as being the temperature 0.0100 degree below that of the triple point of pure water." One can speculate that this remarkable recommendation was proposed because the Consultative Committee hesitated to revise its definition of the Kelvin (or thermodynamic) scale, in which exactly 100 degrees separated the ice and steam points.

The Consultative Committee also used the ice and steam points, with a 100 °C interval, in the definition of the International Temperature Scale of 1948, so that

it, like the Kelvin scale, was in principle a "centigrade" scale. The Ninth General Conference not only accepted both the recommendation on the triple point of water and the ITS-48, but also, in what must be described now as a prescient maneuver, it decided to discontinue the use of the words "Centigrade" and "Centesimal" in favor of "Celsius." (Anders Celsius is credited with having invented, in 1742, a thermometer having 100 degrees between the ice and steam points.)

The 1948 change from "Centigrade" to "Celsius" has largely been ignored in the United States until very recent times. Subsequent actions by the international thermometry establishment, however, have endowed the change with a very concrete rationale, justifying completely the somewhat mysterious move of the Ninth General Conference: During its 1954 meeting, the Consultative Committee on Thermometry proposed to redefine the thermodynamic temperature scale as Lord Kelvin had proposed a century earlier —by referring to an absolute zero of temperature and assigning a defining value to a single temperature reference point. The Consultative Committee's choice was the value 273.16 K assigned to the triple point of water; The International Committee for Weights and Measures recommended this proposal to the Tenth General Conference, and it was accepted. Thus in 1954, the temperature interval between the ice and steam points was no longer 100 °C by definition, but was to be determined by experiment, so that the name "Centigrade" was not only officially rejected but also inaccurate. Finally, the International Committee, acting to avoid ambiguity between the "International Temperature Scale" and the new "International System of Units," recommended that the word "Practical" should be inserted into the title of the temperature scale. The Eleventh General Conference accepted all of these suggestions and promulgated the "International Practical Temperature Scale of 1948, Text Revision of 1960." Although changes were made in 1960 in the definitions of both the thermodynamic temperature scale and the ITS-48, in the fixed points of both scales and in the name of the latter, any changes in actual values of temperature that resulted were smaller than the imprecision of the earlier scale.

Date	Consultative Committee Action
1980	Adoption of the principles for a new scale (for example, the deletion of the thermocouple thermometer as a standard interpolating instrument).
1982	Agreement on a skeleton scale, with numerical values still to be settled.
1984	Essential agreement on the final form of a new scale.
1986	Presentation of the new IPTS to the International Committee for Weights and Measures.

Table 1
Tentative Timetable for a New IPTS

In 1968, a substantially modified scale replaced the IPTS-48. The more precise zinc freezing point (419.58 °C) was substituted for the sulfur point and the tin freezing point (231.9681 °C) was made an alternative to the steam point. In addition, five low-temperature fixed points were added, extending the Scale to −259.34 °C (13.81 K). Finally, new values were assigned to the oxygen boiling point and to the silver and gold freezing points. Together with the zinc-sulfur substitution, these new values resulted in the generation of a wholly new scale. The differences between the IPTS-68 and the IPTS-48 are shown graphically in Figure 1.

In the decade since the IPTS-68 was established, research on thermodynamic thermometry below 0 °C has found little fault with it to temperatures as low as 25 K (—248 °C). Below that temperature, deviations of IPTS-68 from thermodynamic temperatures as large as 8 mK have been deduced from the results of a variety of experiments. These experiments form the basis of the new 0.5 K to 30 K Provisional Temperature Scale which was mentioned earlier.

At temperatures above 0 °C, however, the IPTS-68 has proved to be less reliable in comparison with thermodynamic thermometry experiments. These experiments, which have taken two principal forms, caused a re-evaluation of the IPTS-68 as early as 1975. The first and undoubtedly the most significant of these experiments is a constant volume gas thermometry study at the National Bureau

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Table 2

Outline of the 1976 Provisional 0.5 K to 30 K Temperature Scale (EPT-76)

Basic Reference Point	Assigned Temperature (T_{76}) in kelvins
Superconducting transition point of Cd	0.519*
Superconducting transition point of Zn	0.851*
Superconducting transition point of Al	1.179_6*
Superconducting transition point of In	3.414_5*
Boiling point of ^{4}He at 101 325 pascals (1 std atm)	4.222_1
Superconducting transition point of Pb	7.199_9*
Triple point of equilibrium hydrogen	13.804_4
Boiling point of equilibrium hydrogen at a pressure of 33 330.6 pascals (25/76 std atm)	17.037_3
Boiling point of equilibrium hydrogen	20.273_5
Triple point of neon (2.7 mmol of ^{21}Ne and 92 mmol of ^{22}Ne per 0.905 mol of ^{20}Ne)	24.559_1
Boiling point of neon (same composition)	27.102

**As realized in the NBS SRM 767 device.*

Difference Tables

Differences Between the EPT-76 and the IPTS-68, from 13.81 K to 30 K.

Differences Between the EPT-76 and the and the Helium Vapor Pressure Scales, from 0.5 K to 5.0 K.

Differences Between the NBS Provisional Temperature Scale 2 K to 20 K (1965) and the EPT-76.

Differences Between Several Laboratory Scales and the EPT-76.

Differences Between the NBS IPTS-68 and the EPT-76, from 13.81 K to 30 K.

of Standards. Using the latest technique of residual gas analysis for contaminant gas detection and high-precision methods for measurement of thermal expansion of the thermometer bulb and of the dead volumes, the NBS group, headed by Dr. L. A. Guildner, has substantially improved the classical art. Quoting temperature uncertainties of 2-3 millidegrees from 0 °C to 450 °C, the NBS workers find deviations of the IPTS-68 from the thermodynamic temperatures as large as 80 millidegrees. These results are shown in Figure 2, along with the IPTS-68 stated estimates of uncertainties with respect to thermodynamic temperatures at the steam point and at the freezing points of tin and zinc.

In consideration of these discrepancies, the Consultative Committee on Thermometry moved in 1974 to remove Table 7 from the text of the IPTS-68, and this was accomplished in the text revision of 1975.

The high-temperature experiments which have had a strong bearing upon the current view of the thermodynamic accuracy of the IPTS-68 are those of radiation pyrometry, noise thermometry, and resistance thermometry. J. Bonhoure, working at the International Bureau of Weights and Measures, used the radiation pyrometry method to obtain the data points shown by the symbol □ in the right half of Figure 2. Crovini and Actis at the "G. Colonnetti Institute of Metrology" in Turin, Italy, used a high-temperature noise thermometer to obtain the data points shown by the symbol ϕ.

A similar pattern of deviations was found at the National Bureau of Standards by Evans and Wood using platinum resistance thermometry. Their platinum resistance thermometer was calibrated at the antimony, silver, and gold points, and intermediate values of temperature were obtained from polynomial interpolating equations. The curve which is drawn in the right half of Figure 2 is indicative of the overall pattern of the anticipated corrections to the IPTS-68. The magnitudes of the eventual scale corrections are

subject to modifications because all of the values reported so far are based on ratios to an assumed value for the lower temperature. The modifications are likely to be relatively small, however, so that a strong deviation from thermodynamic temperature almost certainly exists near 800°C on the IPST-68, as shown in Figure 2. These corrections to the current Scale were discussed at some length in the recent meeting of the Consultative Committee for Thermometry.

The 1978 Consultative Committee for Thermometry Meeting

Among the highlights of this year's Consultative Committee meeting were the outlining of a possible timetable for the promulgation of a new International Practical Temperature Scale (this timetable is necessarily tentative, since it depends to a large extent on the progress of continuing temperature research in laboratories throughout the world), the approval of the Provisional 0.5 K-30 K Temperature Scale which will help to satisfy more quickly the current needs in low temperature thermometry, and four recommendations which encourage research work in specific, critical areas of thermometry. Summaries of these highlights are contained in Tables 1, 2, and 3.

Many changes in the IPTS-68 were contemplated by the Consultative Committee. Scale changes inevitably engender substantial equipment expenses within the world wide industrial community, so that modifications of the Scale tend to be approached cautiously. Nevertheless, research in the major thermometry laboratories of the world touches nearly every feature of the present scale. Reported to this Committee meeting were temperature research activities which could lead to the following alterations in the IPTS-68:

—The range of coverage of the International Scale itself. Defined from the melting point of gold (1064 °C) upwards in terms of the Planck Radiation Law, the present scale, as is shown in Figure 2, extends to the triple point of hydrogen (13.81 K or −259.34 °C). The new EPT-76 overlaps the 1968 scale and extends it to the superconductive transition temperature of cadmium (0.5 K). The prevalence of ^3He-^4He dilution refrigerators throughout the scientific world, however, coupled with the progress in fundamental thermometry research below 0.5 K, prompted the suggestion that a new scale might usefully be defined down to 0.01 k.

—The interpolating thermometer to be used in defining the Scale. The platinum-10 percent rhodium vs platinum thermocouple thermometer is the defining instrument between 630 °C and 1064 °C in the present Scale, although its limited accuracy results in calibration uncertainties of 0.2 °C or more in that range. Research in the construction of the platinum resistance thermometer, presently active in several laboratories, indicates that improved models may yield uncertainties as low as 0.04 °C over some or all of the 630 °C-1064 °C range. Success in this area may result in the elimination of the thermocouple thermometer as a defining instrument, and it might affect the lower limit of the radiation range of the scale as well. No single interpolating thermometer has been found to be clearly superior to all others below 13.8 K, but several devices are under study.

—The number and nature of the defining fixed points of the Scale. As noted earlier, the EPT-76 scale includes the temperatures of onset of superconductivity as defining fixed points. This is a type of fixed point which is not found in the present scale. In addition, researchers in several laboratories have suggested the elimination of boiling point temperatures as defining fixed points because of the complication resulting from the necessary pressure measurement and because of the ever-present danger of contamination of such devices. Instead, these scientists are studying the use of a variety of sealed triple point and freezing point devices, which have several advantages: No pressure measurements are needed to accompany a measurement; contamination problems are greatly reduced; and the devices are readily transportable, so that some comparisons of laboratory scales can be accomplished through the exchange of relatively rugged fixed point cells.

—The equations used in the Scale interpolation procedure, and the methods of providing primary calibrations.

Table 3

Four Recommendations of the Consultative Committee on Thermometry, May 1978

1. That research be directed towards the development of platinum resistance thermometers which are satisfactory for use at all temperatures up to the junction temperature between contact and radiation pyrometry.
2. That a more accurate value be sought for the gas constant.
3. That a simplified method for realization of the IPTS-68 be sought.
4. That thermodynamic temperatures between 14 K and 1064 °C be studied, and especially between 14 K and 90 K and between 400 °C and 700 °C.

Editor's note: A fully annotated version of this report is available on request from Dr. Schooley.

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NEW STEEL STANDARD REFERENCE MATERIAL

The NBS Office of Standard Reference Materials announces the availability of a new Standard Reference Material to replace SRM 10g Bessemer Steel, 0.2% carbon.

Standard Reference Material 368 (AISI 1211) is a resulfurized and rephosphorized steel SRM in the form of chips sized between 0.50 and 1.18 mm sieve openings (35 and 16 mesh). It is intended primarily for use in chemical methods of analysis. This material also will be available (in about six months) in the form of disks, SRM 1221, 32 mm (1¼ in) in diameter and 19 mm (¾ in) thick for optical emission and x-ray spectrometric methods of analysis.

SRM 368 is similar in composition to the SRM it replaces, SRM 10g, in that it contains about 0.1% by weight each of phosphorus and sulfur. However, SRM 10g was produced by the Bessemer process of steelmaking, which has not been used for the last several decades.

SRM 368 is typically a free-machining steel by virtue of the resulfurizing and rephosphorizing process and possesses the characteristics of an alloy that provides small broken chip, lower power consumption, better surface finish, and longer tool life. Typical uses are in bolts, screws, and other parts that require extensive machining operations.

This material is being made available through the efforts of the ASTM/NBS Research Associate Program.

This material has been certified for its chemical composition as follows (wt %): C 0.089, Mn 0.82, P 0.084, S 0.132, Si 0.007, Cu 0.010, Ni 0.008, Cr 0.030, V 0.001, Mo 0.003, and N 0.010.

SRM 368 may be purchased from the Office of Standard Reference Materials, Room B311, Chemistry Building, National Bureau of Standards, Washington, D.C. 20234. SRM 368 is priced at $40 per unit of 150 grams.

STANDARD REFERENCE MATERIAL FOR METALS INDUSTRY

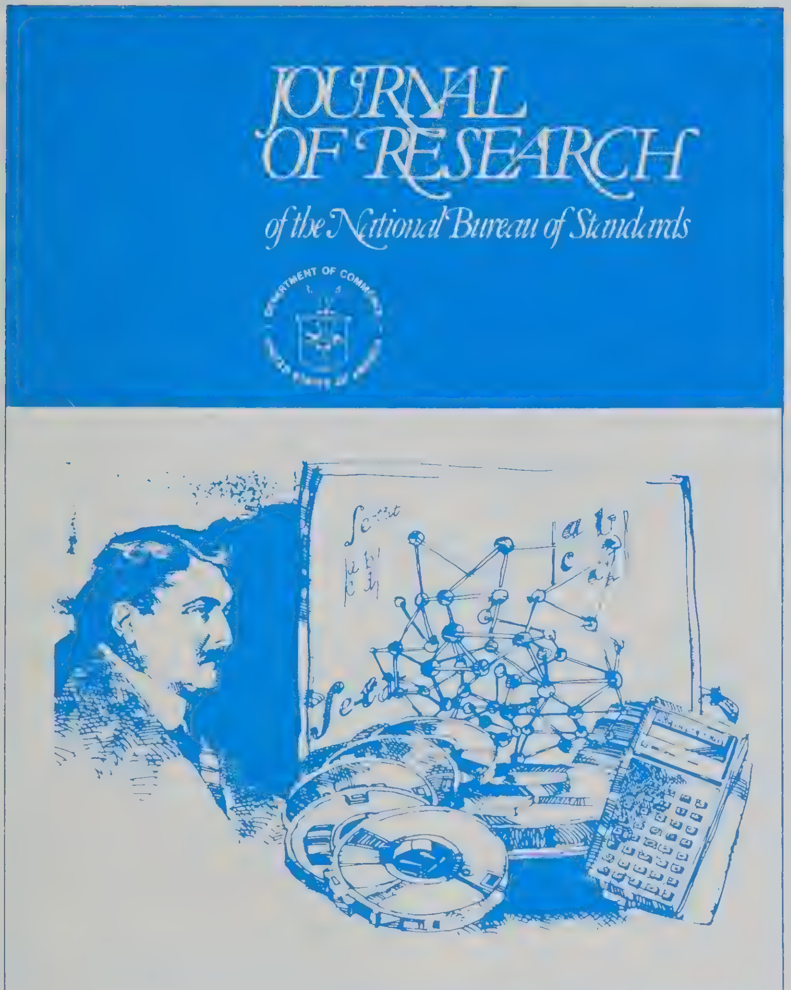
The NBS Office of Standard Reference Materials announces the availability of Standard Reference Material 64c, High-Carbon Ferrochromium.

Based on well documented industrial needs, the preparation of a high-carbon ferrochromium SRM was accepted by the American Society for Testing and Materials/NBS Research Associate Program in late February of 1976. The material for this SRM was prepared at Airco Alloys, Niagara Falls, New York, courtesy of J. E. Cumbo. The material was crushed, ground, and sieved at Union Carbide Corporation, Marietta, Ohio, courtesy of G. Porter. Extensive investigative and processing techniques were employed at NBS, the results of which demonstrated that the selected lot of ferrochromium was of acceptable homogeneity. An Industry-American Society for Testing and Materials-NBS cooperative analytical program was successfully completed, leading to the NBS Certificate of Analysis dated August 1977 for SRM 64c, High-Carbon Ferrochromium.

This material is in the form of fine powder less than 150 μm (100 mesh) for use in checking chemical methods of analysis and in calibration with instrumental methods of analysis. Certification is provided (wt %) for the normally specified elements as follows: Cr 68.00, C 4.68, Mn 0.16, P 0.020, S 0.067, and Si 1.22.

Certification also is made for Cu, Ni, V, Co, Ti, N, and Fe. Although not certified, additional information is provided for Al, As, Mo, O, and Sn.

SRM 64c, High-Carbon Ferrochromium, may be purchased from the Office of Standard Reference Materials, Room B311, Chemistry Building, National Bureau of Standards, Washington, D.C. 20234. This SRM is issued in units of 100 g and is priced at $47 per unit.



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DISTRIBUTED PROCESSING SYMPOSIUM

"Will processing in the future be centralized or distributed, maxi or mini, top-down or bottom-up?" Keynote speaker Lewis M. Branscomb told the 500 participants in the 1978 Trends and Applications Symposium that the "answer to all such questions is 'yes'." The annual technical meeting sponsored by the National Bureau of Standards, the IEEE Computer Society, and the IEEE Washington Section was held May 18 at NBS in Gaithersburg, Maryland.

The symposium theme, distributed processing, was termed an "important area" with an "exciting future" by Branscomb, chief scientist for IBM and a former director of NBS. "Computers will become more useful by being moved closer to people . . . by having their functions distributed, and communications facilities will be more heavily used," predicted Branscomb.

Most current applications of distributed processing are elementary, according to Branscomb, with differences in complexity depending upon whether distributed functions are shared. But he expects distributed processing to be used in a more sophisticated way in the future to "avoid people costs . . ."

Citing the economic trends in data processing, Branscomb said that computer costs are going down faster than communications costs, but that both are going down while people costs go up. According to International Data Corporation estimates for 1975, Branscomb pointed out, people costs—now some 35 percent of the approximately $26 billion annual data processing expenditures in the U.S.—will decline to about 25 percent of the total in the 1980's.

However, there will still be an increase in the absolute number of people employed because of the expected continued increase in money spent for data processing. "So there is . . . no evidence of technological unemployment in the advent of distributed processing," he continued. "What the evidence shows is that as employment grows, the user's capability grows vastly faster as a consequence of the proper use of the mix of technologies."

Rising communications costs in proportion to total data processing costs "certainly are a driving force for innovation in communications services," Branscomb pointed out. Whether that inovation occurs lies "very heavily with Government strategy in this regulated area."

Future distributed systems will "be devised to match need" he said, and among challenging future applications will be "office systems merged with data processing systems." Branscomb observed that the provision of good digital facilities in communications technology is another important future challenge. He discussed other technical issues that have to be addressed: techniques for distributing and finding data, for synchronizing the updating of data, and for communicating practically and economically using data encryption.

NBS Director Ernest Ambler welcomed the symposium attendees and introduced Branscomb, a former NBS director. Ambler spoke of the Bureau's interest in distributed processing for its own labs and offices." By 1986 we plan to have as many as seven host computers, 145 minicomputers, and between 400-500 terminals configured as part of our local network," he said.

NBS plans to interconnect the network components by means of a "carefully designed single interface" that incorporates a microprocessor, according to Ambler. The network, which will be protected by data encryption "where needed," will give NBS staff connections to a variety of computing resources. "They will be able to select the resource which best suits their application. Establishing a connection to any device on the network will be as simple as dialing a phone," he continued.

Symposium participants heard experts from government, industry, and academic organizations discuss issues related to distributed processing. The day-long meeting included five technical sessions devoted to office automation systems, network security techniques, analytical studies of distributed processing systems, network architecture, and network implementations.

Conference proceedings containing the 22 papers that were delivered at the technical sessions may be ordered from the IEEE Computer Society, 5855 Naples Plaza, Suite 301, Long Beach, CA 90803. The document number is 78CH1365-6C and the price is $9.00 for members and $12.00 for nonmembers.

Chairperson of the 1978 Trends and Applications Symposium was Helen M. Wood of the National Bureau of Standards. NBS staffer Robert P. Blanc chairs the IEEE Computer Society, Washington Chapter.

CONFERENCE CALENDAR

September 27-29

FIRE RESEARCH CONFERENCE, NBS, Gaithersburg, MD; sponsored by NBS; contact: Clayton Huggett, B142 Technology Building, 301/921-3771.

October 4-5

CORROSION CONFERENCE, University of Maryland, sponsored by NBS, DOT, and NACE; contact: Paul Campbell, B352 Building Research Building, 301/921-3114.

October 4-6

NATIONAL CONFERENCE OF STANDARDS LABORATORIES, NBS, Gaithersburg, MD; sponsored by NBS and the National Conference of Standards Laboratories; contact: Brian Belanger, A345 Physics Building, 301/921-2805.

October 10-12

3RD ANNUAL CONFERENCE ON MATERIALS FOR COAL CONVERSION AND UTILIZATION, NBS, Gaithersburg, MD; sponsored by NBS and DOE, contact: Samuel Schneider, B308 Materials Building, 301/921-2894.

***October 30**

THE REGULATORY ASPECTS OF BUILDING REHABILITATION, NBS, Gaithersburg, MD; sponsored by State of Mass., NCSBCS, AMCBO, three model building code organizations—BOCA, ICBO, SBCC; NACA, NAHRO, and NBS; contact: James Pilert, B226 Building Research, 301/921-3447.

October 30-November 1

SEMINAR ON HUMAN BEHAVIOR IN FIRES, NBS, Gaithersburg, MD; sponsored by NBS; contact: Bernard Levin, B142 Technology Building, 301/921-3845.

November 2-3

ELECTROMAGNETIC WORKSHOP, NBS, Gaithersburg, MD; sponsored by NBS; contact: Dee Belsher, NBS, Boulder, Colo., 303/499-1000, ext. 3981.

November 13-15

CERAMIC MACHINING AND SURFACE FINISHING II, NBS, Gaithersburg, MD; sponsored by NBS, Office of Naval Research, Air Force Office of Scientific Research, and the American Ceramic Society; contact: Bernard Hockey, A345 Materials Building, 301/921-2901.

November 28-30

MECHANICAL FAILURES PREVENTION GROUP, San Antonio, Texas; sponsored by NBS and MFPG; contact: Harry Burnett, B264 Materials Building, 301/921-2813.

December 4-6

WINTER SIMULATION CONFERENCE, Miami Beach, FL; sponsored by NBS; American Institute of Industrial Engineers; Systems, Man, and Cybernetics Society; Institute of Electrical and Electronics Engineers; Operations Research Society of America, College of Simulation and Gaming, The Institute for Management Sciences and Society for Computer Simulation, The Deauville Hotel Miami Beach, FL; contact: Paul F. Roth, B250 Technology Building, 301/921-3545.

***December 13**

IEEE SYMPOSIUM ON COMPUTER NETWORKING, NBS, Gaithersburg, MD; co-sponsored by National Bureau of Standards' Institute for Computer Science and Technology and the Institute of Electrical and Electronics Engineers Computer Society Technical Committee on Computer Communication; contact: Rob Rosenthal, B212 Technology Building, 301/921-2601.

***December 18-20**

WORKSHOP ON SOFTWARE TESTING AND TEST DOCUMENTATION, Bahia Mar Hotel, Ft. Lauderdale, FL; sponsored by NBS and IEEE Computer Society; contact: Edward E. Miller, Software Research Associates, P.O. Box 2342, San Francisco, CA 94126, 415/921-1155 or 415/957-1441.

1979

April 19-20

5TH ROOFING TECHNOLOGY CONFERENCE, NBS, Gaithersburg, MD; sponsored by NBS and NRCA; contact: Robert G. Mathey, B348 Building Research Building, 301/921-3407.

May 17

TRENDS AND APPLICATIONS SYMPOSIUM, NBS, Gaithersburg, MD; sponsored by NBS, and IEEE; contact: Shirley Watkins, B212 Technology Building, 301/921-2601.

June 11-15

SYMPOSIUM ON ACCURACY IN POWDER DIFFRACTION, NBS, Gaithersburg, MD; sponsored by NBS, National Research Council of Canada, and the International Union of Crystallography; contact: Stanley Block, A219 Materials Building, 301/921-2837.

*New Listings

INS AND OUTS OF DATABASE ADMINISTRATION

Database Administration: Concepts, Tools, Experiences, and Problems, Leong-Hong, B., Marron, B., Nat. Bur. Stand. (U.S.), Spec. Publ. 500-28, 48 pages (Mar. 1978) Stock No. 003-003-01900-3, $2.20.
Technical Profile of Seven Data Element Dictionary/Directory Systems, Leong-Hong, B., Marron, B., Nat. Bur. Stand. (U.S.), Spec. Publ. 500-3, 45 pages (Feb. 1977) Stock No. 003-003-01725-6, $1.05.
A Survey of Eleven Government-Developed Data Element Dictionary/Directory Systems, Nat. Bur. Stand. (U.S.), Spec. Publ. 500-16, 111 pages (Aug. 1977) Stock No. 003-003-01817-1, $2.50.

"Database administrator" (DBA) is not one of your instantly recognizable job titles, but the function it describes is increasingly vital in modern government and business. What DBA's do and how they cope with the problems they encounter are detailed in a new National Bureau of Standards study that emphasizes practical experience and identifies common pitfalls.

Authors Belkis Leong-Hong and Beatrice Marron of the NBS Institute for Computer Sciences and Technology interviewed practicing database administrators in the Federal government. The candid responses they received are reflected in the resulting 44-page booklet.

Titled *Database Administration: Concepts, Tools, Experiences, and Problems,* the study deals with database administration as an emerging discipline that promises significant benefits. The new discipline, according to Leong-Hong and Marron, "encompasses all the technical and management activities required for organizing, maintaining, and directing an organization's data resources, both automated and non-automated."

Improved data security and integrity, fuller use of data in a shared database environment, and faster responses to user needs are cited as typical results of soundly applied database administration.

A section of the report discusses software tools used by DBA's. Described in detail are two particularly useful and mutually reinforcing tools: Database Management Systems (DBMS) and Data Element Dictionary/Directory Systems (DED/D). Two earlier NBS reports examine technical features of both commercial and government-developed DED/D systems for controlling data resources.

NBS HITCHES HF CALIBRATIONS TO RADIO STARS

A Study of Measurement of G/T Using Cassiopeia A, Wait, D. F., Daywitt, W. C., Kanda, M., and Miller, C. K. S., Nat. Bur. Stand. (U.S.), NBSIR 74-382, 186 pages (June 1974), Accession No. AD-783433, $9.25. Available from National Technical Information Service, Springfield, Va. 22151.

For the first time, a research team at the National Bureau of Standards has used radio stars as a standard signal source to make repeatable mesurements of satellite earth terminal sensitivity at frequencies above 6 gigahertz (GHz).

The NBS earth terminal measurement system (ETMS) comprises an instrument and software package developed for the U.S. Army during 5½ years of work by the NBS Electromagnetic Fields Division in Boulder, Colo. The package expands the usefulness of radio-star calibrations to include the 7 GHz down link of the Army's communications satellite earth terminals.

Problems with calibrating satellite earth terminals at high frequencies stem from the low-power emissions from radio stars at those frequencies. Radio stars are still used because they are the only well characterized signal sources meeting all the other necessary criteria, i.e., elevation high enough to eliminate ground signals, distance great enough to be in the antenna's far field, and size small enough to approximate a point source.

"Orbiting standards platforms,"—satellites carrying calibrated antennas, signal sources, and receivers—are in the study stage, and eventually they will provide a much-needed alternative to radio stars. Until they do, the equipment and methods of ETMS will make radio stars a continuingly useful calibration signal source at higher frequencies. This will be increasingly important as commercial communication satellites move to the 11-14 GHz range (expected in the early 1980's).

ETMS uses the customary ratio of antenna gain (G) to system noise (T) as an indicator of earth terminal efficiency. The G/T (read Gee over Tee) ratio, expressed in decibels, is the "figure of merit" for the earth terminal. At 7 GHz, the signal power, or flux, of radio stars is so weak that conventional methods and equipment give inconsistent, and therefore meaningless, G/T measurements. To overcome this, NBS scientists built the ETMS instrument package around the NBS Type IV power meter—the most accurate power meter known—to minimize power measurement anomalies.

They attacked other systematic errors with software that corrects for gain fluctuations of the earth terminal itself; atmospheric transmission losses; "non-point source" (geometric variation) of the calibrating radio star; system component frequency variation across the passband; operating noise temperature frequency variation across the passband; imperfect earth terminal antenna point; polarization mismatch between the star and antenna; and finite response time of the ETMS.

Building Technology

Weber, S. G., Translation Ed., Building Research Translation: French Acoustical Comfort Standards, Nat. Bur. Stand. (U.S.), Tech. Note 710-8, 67 pages (Mar. 1978) Stock No. 003-003-01897-0, $2.30.

Computer Science and Technology

Evans, J. M., Jr., Albus, J. S., and Barbera, A. J., Eds., Computer Science and Technology: NBS/RIA Robotics Research Workshop. Proceedings of the NBS/RIA Workshop on Robotic Research held at Williamsburg, VA, July 12-13, 1977, Nat. Bur. Stand. (U.S.), Spec. Publ. 500-29, 40 pages (Apr. 1978) Stock No. 003-003-01909-7, $1.60.

Leong-Hong, B., and Marron, B., Computer Science and Technology: Database Administration: Concepts, Tools, Experiences, and Problems, Nat. Bur. Stand. (U.S.), Spec. Publ. 500-29, 48 pages (Mar. 1978) Stock No. 003-003-01900-3, $2.20.

White, W. W., Computers and Mathematical Programming. Proceedings of the Bicentennial Conference on Mathematical Programming held at the National Bureau of Standards, Gaithersburg, MD, Nov. 29-Dec. 1, 1976, Nat. Bur. Stand. (U.S.), Spec. Publ. 502, 383 pages (Feb. 1978) Stock No. 003-003-0189-3, $5.50.

Health and Safety

Directory of Law Enforcement and Criminal Justice Associations and Research Centers, Law Enforcement Standards Laboratory, Nat. Bur. Stand. (U.S.), Spec. Publ. 480-30, 51 pages (Mar. 1978) Stock No. 003-003-01904-6, $2.20.

Steinberg, H. H., Auto Headlight Glass: Visible Features of Forensic Utility, Nat. Bur. Stand. (U.S.), Spec. Publ. 480-17, 137 pages (Feb. 1978) Stock No. 003-003-01857-1, $3.

Electronic Technology

Christou, A., Semiconductor Measurement Technology: Automated Scanning Low-Energy Electron Probe (ASLEEP) for Semiconductor Wafer Diagnostics, Nat. Bur. Stand. (U.S.), Spec. Publ. 400-30, 38 pages (Apr. 1978) Stock No. 003-003-01905-4, $1.50.

Novotny, D. B., and Ciarlo, D. R., Semiconductor Measurement Technology: Automated Photomask Inspection, Nat. Bur. Stand. (U.S.), Spec. Publ. 400-46, 38 pages (Apr. 1978) Stock No. 003-003-01912-7, $1.50.

Thurber, W. R., and Buehler, M. G., Semiconductor Measurement Technology: Microelectronic Test Pattern NBS-4, Nat. Bur. Stand. (U.S.), Spec. Publ. 400-32, 66 pages (Apr. 1978) Stock No. 003-003-01906-2, $2.75.

Energy Conservation and Production

Tietsma, G. J., and Peavy, B. A., The Thermal Performance of a Two-Bedroom Mobile Home, Nat. Bur. Stand. (U.S.), Bldg. Sci. Ser. 102, 59 pages (Feb. 1978) Stock No. 003-003-01863-5, $2.30.

Engineering, Product and Information Standards

McEwen, H. E., Transmittal Form for Describing Computer Magnetic Tape File Properties, Nat. Bur. Stand. (U.S.), Fed. Info. Process. Stand. Publ. (FIPS PUB) 53, 4 pages (1978).

Environmental Studies: Pollution Measurement

Rook, H. L., and Goldstein, G. M., Eds., The National Environmental Specimen Bank. Proceedings of the Joint EPA/NBS Workshop on Recommendations and Conclusions of the National Environmental Specimen Bank held at the National Bureau of Standards, Gaithersburg, MD, Aug. 19-20, 1976, Nat. Bur. Stand. (U.S.), Spec. Publ. 501, 59 pages (Feb. 1978) Stock No. 003-003-01890-2, $2.30.

Yaniv, S. L., and Flynn, D. R., Noise Criteria for Buildings: A Critical Review, Nat. Bur. Stand. (U.S.), Spec. Publ. 499, 82 pages (Jan. 1978) Stock No. 003-003-01870-8, $2.40.

Low Temperature Science and Engineering

Johnson, W. W., and Jones M. C., Measurements of Combined Axial Mass and Heat Transport in He II, Nat. Bur. Stand. (U.S.), Tech. Note 1002, 84 pages (Feb. 1978) Stock No. 003-003-01889-9, $2.40.

Nuclear Physics and Radiation Technology

Bowman, C. D., Carlson, A. D., Liskien, H. O., and Stewart, L., Eds., Neutron Standards and Applications. Proceedings of the International Specialists Symposium on Neutron Standards and Applications held at the National Bureau of Standards, Gaithersburg, MD, Mar. 28-31, 1977, Nat. Bur. Stand. (U.S.), Spec. Publ. 493, 379 pages (Oct. 1977) Stock No. 003-003-01847-3, $8.50.

Publications cited here may be purchased at the listed price from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402 (foreign: add 25%). Microfiche copies are available from the National Technical Information Service, Springfield, VA 22161. For more complete periodic listings of all scientific papers and articles produced by NBS staff, write: Editor, Publications Newsletter, Administration Building, National Bureau of Standards, Washington, D.C. 20234.

NEWS BRIEFS

CAPITOL HILL AND NBS. Breaking with past tradition, Congress has taken the first step toward periodic review of the mission and work of NBS as a result of recently enacted legislation. Capitol Hill lawmakers are slated to take a look at how NBS fares in the spring of 1980, and the Bureau will probably be reviewed at least every other year after that. House Science and Technology Committee Chairman Olin Teague has said he believes that this will help assure that NBS will be able to make "its maximum contribution to the scientific knowledge and technology so important to our industrial innovation, growth, and economic well-being."

COMPUTERS AND PEOPLE MEET IN THE MARKETPLACE. A Consumer guide to computerized systems in stores and banks has been published by the National Bureau of Standards. Called Automation in the Marketplace (Consumer Information Series 10), the publication is for sale by the Superintendent of Documents, U.S. GPO, Wash., D.C. 20402. The price is 90 cents. Order by Stock Number 003-003-01969-1.

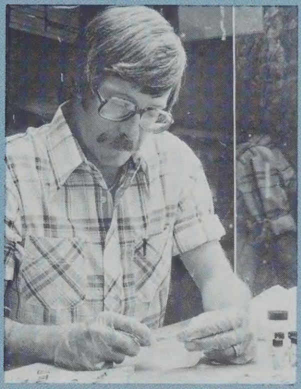
NBS-COMPUTER INDUSTRY TEAMWORK. Computer firms and their trade and professional associations are invited to sponsor Research Associates to work with staff of the National Bureau of Standards in developing the technical foundation for future Federal computer interface standards. The interface technology program will focus on computer systems, network architectures, and interconnection techniques likely to be in widespread use in the next 5 to 10 years. For information, contact Thomas N. Pyke, Jr., Chief, Computer Systems Engineering Division, A231 Technology, NBS, Wash., D.C. 20234.

COOPERATIVE TECHNOLOGY. NBS has set up an office to study the feasibility and design of a Federal Government-industry-academia "cooperative technology" program. If undertaken, such a joint effort could involve Federal participation in stimulating industry and university research in technologies critical to U.S. industry. The Federal Government would also work with industry and academia in strengthening and establishing institutions to spur the development and dissemination of those technologies. The study by the new NBS Office of Cooperative Technology will take 12 months.

PUBLICATIONS CATALOG AVAILABLE. Nearly 1900 scientific and technical papers were published last year by NBS on subjects ranging from A (abnormal loading of structures) to Z (zero-shift in pressure measurement). They are referenced in Publications of the National Bureau of Standards, NBS Special Publication 305, Supplement 9, for sale by the Superintendent of Documents, U.S. G.P.O., Wash., D.C. 20402. Orders must include Stock Number 003-003-01951-8; price $7.50; add 25% for foreign mailing.

NEXT MONTH IN

DIMENSIONS/NBS



The NBS nuclear reactor is a national resource available to researchers inside and outside government. Read about one use of the reactor by a Smithsonian Institution scientist interested in tracing history with the aid of neutrons—next month in DIMENSIONS/NBS.

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